ce Abstracts

Section A

Physics Abstracts

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PHYSICS ABSTRACTS

lume 64 DECEMBER 1961 (Part II) Number 768(Pt II)

MATHEMATICS

17978 GREEN'S FUNCTION OF THE METAHARMONIC OPERATOR FOR DIRICHLET'S OR NEUMANN'S
)BLEMS IN THE INTERIOR OF A CIRCLE OR OF A SPHERE.
:ienne and F.Thiry.
.. Soc. Roy. Sci. Liege (Belgium), Vol. 30, No. 9-10, 416-26
1). In French.

Different expressions for the Green's functions of the operator
+ K^2 are given. The elementary solutions were given previously
tienne [Bull. Soc. Roy. Sci. Liege (Belgium), Vol. 27, No. 5-6,
-56; No. 7-8, 189-200 (1958)]. F.Herbut

17979 ON A GENERALISATION ON THE PROBLEM OF DETERMINING UNITARY MATRICES. A.Pozwolski.
'hys. Radium (France), Vol. 22, No. 5, 326 (May, 1961).
'rench.

A matrix "S" is said to be unitary when its inverse is equal to
ranspose. A generalization is X'X = A where "A" is a symmet-
non-singular matrix. This note deals with the determination
ne components of X in terms of the components of $G = A^{-1}$.
G.S.Brosan

17980 LINEAR DIFFERENTIAL OPERATORS. C.Lanczos.
don, Toronto, New York, Princeton, N.J., D. Van Nostrand
1) xvi + 564 pp.

The book is intended for physcists, engineers and applied
nematicians. It is written at an advanced level but does not
ime any mathematical knowledge beyond that included in a
nal degree course; the tools of the subject are developed as
narration proceeds. There are nine chapters, the first three
g introductory; titles are: (1) Interpolation; (2) Harmonic
lysis; (3) Matrix Calculus; (4) The Function Space; (5) The
en's Function; (6) Communication Problems; (7) Sturm—
ville Problems; (8) Boundary Value Problems; (9) Numerical
tion of Trajectory Problems. Total of 350 problems are posed
solved) in the course of the discussions.

17981 ANALYSIS OF A NONLINEAR FIRST-ORDER SYSTEM WITH A WHITE NOISE INPUT.
.Caughey and J.K.Dienes.
ppl. Phys. (USA), Vol. 32, No. 11, 2476-9 (Nov., 1961).

A general technique for computing the power spectrum of non-
ar systems is presented, and the method is applied to the
wnian motion of a particle with idealized Coulomb damping. In
method the transition probability is obtained by solving the
'opriate Fokker—Planck equation. The autocorrelation function
alculated by an appropriate integration, and the power spectrum
d by means of the Wiener—Khintchine relation. Comparison is
e with the method of equivalent linearization, which is applic-
to a wide class of nonlinear problems.

7982 THE CORRECTION OF RESONANCE PEAKS FOR EXPERIMENTAL RESOLUTION.
.Lane, N.F.Morehouse, Jr and D.L.Phillips.
lear Instrum. and Methods (Internat.), Vol. 9, No. 1, 87-91
., 1960).

A technique is discussed for the determination of the true
onance shape from a measured resonance shape when the appar-
resolution shape is known, or conversely, the determination of
resolution function if the true resonance shape is known. The
olem is essentially that of the solution of an integral equation of
first kind and use is made of the relations among the Fourier
ficients to determine the unknown function. A successful appl-
on is made to the case of a resonance in the total neutron cross-
ion of carbon where the widths of the resonance and resolution function are comparable. Some of the limitations of the technique are discussed.

17983 A SLIDE RULE TO WORK OUT NUCLEAR PARTICLES TRACK LENGTHS. C.Karadeniz.
Rev. Fac. Sci. Univ. Istanbul C (Turkey), Vol. 26, No. 1, 64-6 (Jan., 1961).

A slide rule is described evaluating the hypotenuse in Pythagoras' formula operating in three dimensions.

17984 ANALOGUE COMPUTER FOR THE SUMMATION OF FOURIER SERIES WITH DIGITAL RECORDING OF THE RESULTS. T.Lundström and V.Klimecki.
J. sci. Instrum. (GB), Vol. 38, No. 11, 424-7 (Nov., 1961).

An a.c. analogue computing machine is described, which carries out the summation of the Fourier series

$$\sum_{h=0}^{H} A_h \cos 2\pi hx + \sum_{h=0}^{H} B_h \sin 2\pi hx$$

with $H_{max} = 40$ for every third degree. The calculation is performed by a method in principle given by Hägg and Laurent (Abstr. 2223 of 1946). Voltages from an autotransformer, proportional to the trigonometric functions, are connected to decade potentiometers, introducing the coefficients via rotary switches. From these potentiometers small currents are fed to a common impedance, and the voltage over this gives the sum of the Fourier series. The result is converted to digital form by means of a relay system and printed automatically. The time necessary for one summation is 3 seconds. An example showing the accuracy is given.

17985 THE STRUCTURE OF PURELY NON-DETERMINISTIC STOCHASTIC PROCESSES. H.Cramér.
Ark. Mat. (Sweden), Vol. 4, Paper 19, 249-66 (1961).

A contribution to the mathematical theory of vector stochastic processes in continuous time. Under suitable restrictions such processes can be decomposed into a deterministic part for which the remote past contains complete information about the process and a purely non-deterministic part in which the remote past contains no information at all. It is shown here that the latter part (x) can be represented as a linear combination of orthogonal processes

$$z_n:\ x(t) = \sum_{n=1}^{N} \int_{-\infty}^{t} g_n(t,\lambda)\,dz_n(\lambda),$$

where N may be finite or denumerably infinite.
R.O.Davies

17986 MOMENTS OF THE GENERALIZED RAYLEIGH DISTRIBUTION. J.H.Park, Jr.
Quart. appl. Math. (USA), Vol. 19, No. 1, 45-9 (April, 1961).

A generalized Rayleigh random variable, Y, (also referred to as a non-central chi-square variable) is defined by

$$Y^2 = \sum_{i=1}^{N} X_i^2$$

where X_i, i = 1,2,..., N are independent Gaussian random variables with means $\bar{x}_1, \bar{x}_2, \ldots, \bar{x}_N$ respectively and equal variances of one. An expression is obtained for the moments of the distribution in terms of N, a, and y_0 where

$$y_0^2 = \sum_{i=1}^{N} \bar{x}_i^2.$$

From this expression asymptotic expansions are obtained for the moments corresponding to large N and large y_0. Formulae are obtained giving recursion relations between moments of order a and a + 2, and also two simple expressions which are upper bounds on negative integer moments. A.J.McTernan

ASTROPHYSICS

17987 COLLIMATION ERRORS IN ASTRONOMICAL OBSERVATIONS. G.P.Pil'nik.

Astron. Zh. (USSR), Vol. 37, No. 3, 567-78 (May-June, 1960). In Russian.

Observations of collimators at zenith and horizon revealed quite appreciable errors in the position of the line of sight in two transit instruments. A comparison of observations of the collimators and of stars leads to the conclusion that the worst errors in astronomical observations are collimation errors. Some of the possible causes for variations in collimation are considered. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 3, 539-48 (Nov.-Dec., 1960)].

17988 NOTE TO "PROBLEMS IN MERIDIAN ASTRONOMY E.Høg.

Astron. J. (USA), Vol. 66, No. 9, 531-2 (Nov., 1961).

See Abstr. 5121 of 1961. Random fluctuations in extinction are shown not to introduce serious errors in transit times measured photoelectrically by the method proposed for the Hamburg Observatory.

17989 A NEW DESIGN OF A DIFFERENTIAL PHOTOMETER FOR A SOLAR MAGNETOGRAPH. L.M.Kotlyar.

Astron. Zh. (USSR), Vol. 37, No. 3, 469-75 (May-June, 1960). In Russian.

The instrument differs from the existing types in that one photomultiplier is used instead of two, and that there is auxiliary modulation of the light beam by means of an electro-optical crystal modulator. Analytical expressions describing the process of transformation of the light beam in the instrument are given. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 3, 445-50 (Nov.-Dec., 1960)].

17990 A NEW TECHNIQUE IN THE USE OF THE ELECTRONIC CAMERA. M.Duchesne.

C.R. Acad. Sci. (France), Vol. 253, No. 3, 417-9 (July 17, 1961). In French.

To obviate some of the major difficulties involved in dismantling, and re-loading the Lallemand camera between exposures at the telescope, a new technique is described in which activated charcoal is used to maintain the high vacuum necessary for the proper functioning of the camera. During a night's operation a vacuum better than 10^{-7} torr can be maintained without difficulty. D.R.Barber

17991 A NEW COMA-FREE CASSEGRAIN SYSTEM. H.Köhler.

Optik (Germany), Vol. 17, No. 9-10, 485-90 (Sept.-Oct., 1960). In German.

A Cassegrain system consisting of a spherical primary mirror, an over-hyperbolic, figured secondary mirror and an afocal system located in the neighbourhood of the focus is described. The system is intended for a primary mirror diameter of one metre, a focal length of 20 metres and an image diameter in the image plane of 140 mm. It is in course of construction for the Caracas Observatory (Venezuela). The results of trigonometrical ray tracing are given and a number of constructional details described.

17992 INAUGURATION OF THE TAUTENBURG-JENA 2m MIRROR INSTITUTE OF THE GERMAN ACADEMY OF SCIENCES WITH ASTRONOMICAL APPARATUS OF THE JENA OPTICAL WORKS.

Optik (Germany), Vol. 18, No. 2, 92-4 (1961). In German.

PHOTOGRAPHIC PHOTOMETRY OF LARGE AREAS.

See Abstr. 18560

17993 A THEOREM ON ROTATING POLYTROPES. S.Chandrasekhar.

Astrophys. J. (USA), Vol. 134, No. 2, 662-4 (Sept., 1961).

An expression for the potential energy of a rotating polytrope is obtained by combining the equation of the virial appropriate for rotating configurations with an elementary integral of the equations of hydrostatic equilibrium. G.A.Chisnall

17994 ORBITS IN THE PROBLEM OF TWO FIXED CENTR V.G.Demin.

Astron. Zh. (USSR), Vol. 37, No. 6, 1068-75 (Nov.-Dec., 1960). In Russian.

The problem of two fixed centres is considered. Differentia equations of motion expressed in generalized Thiele (1895) varia were formed for the case of motion in space and the problem red to quadratures. In the case of motion in a plane, equations of the orbits were obtained for some types of motion in a form which is convenient for practical use. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 6, 1005-12 (May-June, 1961)].

17995 A THEOREM IN THE THEORY OF PERTURBED MOTION. V.M.Alekseev.

Astron. Zh. (USSR), Vol. 38, No. 2, 325-34 (1961). In Russian.

The following system of differential equations is considered:

$$\frac{d\bar{r}}{dt} = \bar{u}; \frac{d\bar{u}}{dt} = -\frac{\mu \bar{r}}{r^3} + \bar{\Phi}(\bar{r}, \bar{u}, t).$$

This system describes the relative motion of two bodies under th influence of Newtonian gravitation, and also perturbations of any kind. It is proved that this system is equivalent to the system of integral equations:

$$\bar{r}(t) = \bar{r}_0 + \int_{t_0}^{t} \bar{u}(s)\,ds; \quad \bar{u}(t) = \bar{U}(\bar{r}_0, \bar{u}_0, t - t_0)$$

$$+ \int_{t_0}^{t} A(\bar{r}(s), \bar{u}(s), t - s)\,\bar{\Phi}(\bar{r}(s), \bar{u}(s), s)\,ds$$

where $\bar{U}$ is the velocity of the unpertubed Kepler motion, $A = \partial\bar{u}/\partial\bar{u}_0$), a matrix whose elements are derived in the append [English translation in: Soviet Astron.—AJ (USA), Vol. 5, No. 2, 242-8 (Sept.-Oct., 1961)].

17996 ONE CLASS OF PERIODIC SOLUTIONS IN THE RESTRICTED THREE-BODY PROBLEM. E.P.Aksenov.

Astron. Zh. (USSR), Vol. 38, No. 2, 336-44 (1961). In Russian.

The restricted circular three-body problem is considered. The assumption that one of the finite masses is small is not made The existence of a new class of spatial periodic solutions of this problem is proved, and the first terms of the series representing these solutions are obtained. The orbits which correspond to these solutions include both of the attracting bodies. A peculiar of the orbits obtained is that their nodes exhibit secular motion. [English translation in: Soviet Astron.—AJ (USA), Vol. 5, No. 2, 249-54 (Sept.-Oct., 1961)].

17997 ON RELATIVISTIC COSMOLOGY. J.Pachner.

Ann. Phys. (Germany), Vol. 8, No. 1-2, 60-75 (1961). In German

The foundations of relativistic cosmology are developed without making use of the matter tensor. The starting points are tak as three simple and plausible postulates from which the dynamic equation of the universe is derived in full generality. The equati is then applied to the investigation of three different worlds. The by a simple relation can be derived with the help of which the question whether the universe is pulsating or extends up to infini can be answered. It is further proved that the cosmological constant actually represents $1/(8\pi)$ times the density, measured in geometrical units, of the mass newly created in the universe fro nothing, and that the de-Sitter world is not empty but is full of su continuously created matter. The connection of this investigatio with the works of Friedman, Einstein and McCrea is discussed. Lastly the size of the visible region of the universe is determine and is utilised to make a quantitative examination of the "steady-state universe" hypothesis of Hoyle and McCrea. Vachas

17998 REFORMULATION OF NON-STATIC COSMOLOGICA MODELS. P.Sen Gupta.

Ann. Phys. (Germany), Vol. 8, No. 7-8, 397-401 (1961).

The possibilities of reformulations of cosmological models discussed with matter density as a function of r and t; this is thought to be more general than the previous models. It gives $P = \rho/3$.

7999 THE PREVAILING ORIENTATION OF FRAGMENTS FORMED BY STRATIFICATION OF A HOMOGENEOUS AVITATING MEDIUM IN A MAGNETIC FIELD. R.S.Oganesyan.
ron. Zh. (USSR), Vol. 37, No. 4, 665-70 (July-Aug., 1960).
Russian.

It is established that a space-homogeneous distribution of a vitating mass with constant density (a flat layer) and an internal gnetic field is unstable and should, as a rule, disintegrate into arate fragments, which have a tendency to be located along gnetic lines of force. [English translation in: Soviet Astron.— (USA), Vol. 4, No. 4, 634-9 (Jan.-Feb., 1961)].

18000 THE APPROXIMATE SOLUTION OF THE TRANSFER EQUATION FOR A PLANE GRAY PHOTOSPHERE KING ACCOUNT OF THE BLANKETING EFFECT. S.V.Rublev.
tron. Zh. (USSR), Vol. 37, No. 4, 677-85 (1960). In Russian.

A "mean cosine" method is developed and applied to the solu- n of the transfer problem in a plane-parallel gray photosphere. eneralized linear approximation for $B(\tau)$ is obtained, taking into ount the blanketing effect produced by the reversing layer. A thod of deriving the second approximation of $B(\tau)$ is given. In case of the sun, a comparison is made with Przybylski's model str. 18745 of 1960). [English translation in: Soviet Astron.—AJ A), Vol. 4, No. 4, 645-52 (Jan.-Feb., 1961)].

18001 SOME QUESTIONS OF RELATIVISTIC COSMOLOGY. J.Pachner.
l. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), . 8, No. 11-12, 789-94 (1960).

Discusses (i) the time-dependence of expansion and (ii) the erpretation of material density, in the author's form of mological theory (Abstr. 11672 of 1961). F.A.E.Pirani

18002 APPARENT RECESSION OF NEBULAE AND THE NATURE OF RADIO STARS. N.S.Japolsky.
ture (GB), Vol. 191, 480-2 (July 29, 1961).

The whirl theory of light and matter, quantitative evidence for ich was given in Abstr. 11693 of 1961, is shown to imply that a oton emitted from a source increases its wavelength continuously, increase tending rapidly, though asymptotically, to proportional- to the distance from the source. Such a theory of the "red shift" the spectra of nebulae renders unnecessary the hypothesis of the anding universe. The author maintains that this is equally true relation to similar phenomena in radio stars which, from the nt of view of whirl theory, he regards as consisting of atom- or lecule-like formations of particle-like compound whirls of com- atively large dimensions (macroparticles) which should emit otons of correspondingly large dimensions (macrophotons). The ory shows that the de Broglie wavelengths tend to become pro- tional to the distance from the axis. M.Kasha

18003 AN UNSTEADY UNIVERSE WITH EXCESS OF CHARGE. L.G.Chambers.
ture (GB), Vol. 191, 1082-3 (Sept. 9, 1961).

Modified electromagnetic equations involving a creation ential are applied to Milne's kinematic model universe with ession velocity $\alpha r/t$. The rate of charge creation is found to be portional to $(\alpha - 1)(3\alpha - 2)/t^3$. It is suggested that an estimate the value of α could be derived from the observed distance iation of velocity and mass density. R.A.Newing

18004 THEORY OF THE RED SHIFT AND THE NATURE OF PLANCK'S CONSTANT. L.Infeld.
ure (GB), Vol. 191, 1184 (Sept. 16, 1961).

Points out that the definition of frequency may be based on assical) Maxwell's theory or on quantum theory.
F.A.E.Pirani

18005 THE IDEA OF SIZE IN LARGE-SCALE PHYSICS. E.W.Bastin.
oc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 4, 848-50 (Oct., 1961).

Suggests that it may be necessary for cosmological theory to andon the usual assumption that there is a fixed metric defining distribution of matter in space, and to use a geometrically aker algebra to establish fundamentals, relying on the dimension- s constants as the basic measurable quantities. Comparison is de with the situation in quantum theory as regards the limitations the measurement process. J.Hawgood

18006 COSMOLOGICAL IMPLICATION OF PHYSICAL CONSTANTS. S.Hayakawa and H.Tanaka.
Progr. theor. Phys. (Japan), Vol. 25, No. 5, 858-60 (May, 1961).

The authors surmise that the numerical values of the universal physical constants would eventually be derived from something more fundamental and speculate about the value of gravitational constant and Planck constant from cosmological considerations. They estimate $G \cong 10^{-7}\ \mathrm{cm^3\ sec^{-2}\ g^{-1}}$ and $h \cong 10^{-27}$ erg sec.
S.P.Talwar

18007 THE UPPER LIMIT OF NEUTRINO, GRAVITON AND BARYON DENSITY IN THE UNIVERSE.
Ya.B.Zel'dovich and Ya.A.Smorodinskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 907-11 (Sept., 1961). In Russian.

In order to estimate the energy density of neutrinos and other weakly interacting particles in the universe, the gravitational effect of these particles on the expanding universe is considered. It is found that the energy density does not exceed 2×10^{-28} $(\mathrm{g\ cm^{-3}}) \times c^2 = 2 \times 10^{-7}\ \mathrm{erg\ cm^{-3}}$. This estimation is much more accurate (lower) than that based on nuclear-physical experiments. Stars with a large gravitational mass defect are considered and in this connection an upper estimation of the nucleon density is presented. Present day data do not exclude the possibility that the density of those forms of matter which are not easily observed and the nucleon density in this state of difficult observation are several times higher than that of easily observable forms of matter and energy, as exemplified by nucleons in ordinary stars and interstellar gas. [English translation in: Soviet Physics—JETP (USA)].

ON SLOW AND RAPID NEUTRON-CAPTURE PROCESSES IN THE THEORY OF ORIGIN OF THE ELEMENTS. See Abstr. 17109

ABSORPTION OF HIGH ENERGY PHOTONS IN THE UNIVERSE. See Abstr. 16737

18008 AN ATTEMPT TO DETECT THE 327 Mc/s LINE OF GALACTIC DEUTERIUM. R.L.Adgie.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 352-4.

A receiver with 11 channels was used to try and detect deuterium in the absorption spectra of Sagittarius-A and Cassiopeia-A using the 250 ft radio telescope at Jodrell Bank which gave an effective integration time of 18 hours. No deuterium was observed and the ratio of the abundance of neutral hydrogen to that of deuterium is accordingly greater than 4×10^3. R.D.Davies

18009 SUBSTRUCTURE WITHIN GALACTIC SPIRAL ARMS AS DERIVED FROM STUDIES AT 21 cm. R.D.Davies.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 355-9.

Dense neutral hydrogen clouds several degrees in diameter were observed in the constellations of Auriga and Cygnus. They have kinetic temperatures in the range 25° to 60° and are cooler than the average clouds seen in emission. However they coincide in position with dense dust clouds where theory suggests that the cooling processes are faster. The "local system" of B-stars and dust has also a high density of neutral hydrogen. R.D.Davies

18010 THE DISTRIBUTION OF NEUTRAL HYDROGEN IN THE ORION REGION. H.van Woerden.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 370-3.

Neutral hydrogen profiles at 250 positions in the Orion Region were taken. There is broad agreement with Menon's earlier conclusion that the gas in Barnard's ring is expanding. Good correlation between neutral hydrogen density and optical absorption is found in a number of areas. R.D.Davis

18011 ATOMIC HYDROGEN SURVEY NEAR THE GALACTIC PLANE.
B.F.Burke, E.T.Ecklund, J.W.Firor, H.E.Tatel and M.A.Tuve.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 374-89.

Neutral hydrogen profiles were obtained for regions near the galactic plane over half the sky visible from Washington using a 54 channel hydrogen-line receiver in conjunction with an aerial having a beamwidth of 2° × 3°. The bandwidth of each channel is 12 kc/s and the channels cover a frequency range of 1 Mc/s at any one time. R.D.Davies

18012 A SURVEY OF NEUTRAL HYDROGEN AT HIGH GALACTIC LATITUDES.
W.C.Erickson, H.L.Helfer and H.E.Tatel.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 390-7.

The 54 channel hydrogen-line receiver was used to obtain a grid of profiles about 10° apart in galactic latitude and longitude at latitudes greater than 20°. There are systematic departures of the line velocities from the local standard of rest at large distances from the plane. These effects cannot be explained through a K-term or a streaming motion alone. R.D.Davies

18013 A SUMMARY AND ASSESSMENT OF CURRENT 21 cm RESULTS CONCERNING SPIRAL AND DISK STRUCTURES IN OUR GALAXY. J.H.Oort.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 409-15.

Neutral hydrogen is distributed throughout the Galaxy in a remarkably flat layer, only 220 parsecs thick to half density points. The 21 cm results give a good rotation curve for $R < 8$ kiloparsecs. The density distribution within the galaxy shows a spiral pattern although the connection between the arms seen in the northern and southern hemispheres is ambiguous. The density of neutral hydrogen shows a maximum at $R = 6$ kiloparsecs, whereas ionized hydrogen has a maximum at $R = 4$ kiloparsecs. R.D.Davies

18014 NEUTRAL HYDROGEN IN THE CENTRAL PART OF THE GALACTIC SYSTEM. G.W.Rougoor and J.H.Oort.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 416-22.

The high velocity wings observed in the neutral hydrogen profiles from directions near the galactic centre are interpreted as due to neutral hydrogen in the central regions being in expansion and at the same time taking part in galactic rotation. A number of minor arms can be distinguished as well as the major expanding arm at $R = 3$ kiloparsecs. The gas expansion amounts to one solar mass per year passing through a cylinder of radius 3 kiloparsecs.
R.D.Davies

18015 THE DETECTION OF NEW CLOUDS OF IONIZED HYDROGEN IN THE GALAXIES.
G.Courtès and P.Cruvellier.
C.R. Acad. Sci. (France), Vol. 253, No. 2, 218-20 (July 10, 1961).
In French.

Photographs in Hα light of M 33, NGC 4258, M 101, and NGC 4565, taken through a 250 A band-pass filter centred on Hα, reveal extensive areas of cloud-like emission in these objects.
D.R.Barber

INTERSTELLAR CLOUD STRUCTURE. See Abstr. 18210

18016 THE INCIDENCE OF INTERPLANETARY DUST. T.R.Kaiser.
Ann. Geophys. (France), Vol. 17, No. 1, 50-9 (1961).

Interplanetary dust can be investigated in a number of ways, these include optical and radio meteor observations, the collection at the earth's surface of accreted particles, the scattering of sunlight (the zodiacal light), as well as more direct observations with rocket and satellite borne instruments. This paper treats in some detail the reduction of radio-echo data to yield the absolute incident meteor flux. Observational data, obtained by the various techniques listed above, are presented and the problems in reconciling them are discussed.

18017 THE MAGNETIC FIELDS IN INTERPLANETARY SPACE AS DERIVED FROM OBSERVATIONS OF THE COSMIC RAY SOLAR FLARE EFFECTS.
K.G.McCracken and R.A.R.Palmeira.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961). p. 44.

A study of the temporal variation of cosmic ray intensity following the production of cosmic radiation by a solar flare event. Quantitative comparisons of recent cosmic ray events show that the flares responsible for the 4 cosmic ray increases exhibiting the shortest time-scales occurred at the sun's W limb, whilst the 3 increases showing the longest time-scales were initiated by flares near the centre of the solar disk. These facts support Piddington's theoretical arguments (Abstr. 2007 of 1959). D.R.Barber

18018 EXPANSION OF A SODIUM CLOUD IN INTERPLANETARY SPACE. S.A.Kaplan and V.G.Kurt.
Astron. Zh. (USSR), Vol. 37, No. 3, 536-42 (May-June, 1960).
In Russian.

The problem of the expansion of a gas into a vacuum is dis both theoretically and experimentally (in terms of observations o sodium clouds released from rockets). It is shown that the expa proceeds in two stages: a stage of adiabatic expansion and a sta of free expansion. During the first stage, the temperature falls 350 to 600 deg K, and the atoms maintain their thermal velocitie during the second. Formulae, relating the rate of adiabatic expansion a and the thermal velocity of the second stage c_k, are derived, as well as formulae for the density distribution and su brightness. Reduction of the observational data reveals excelle agreement with theory, and leads to the determination of the rat expansion $a = 1.40$ km sec^{-1} and $c_k = 0.87$ km sec^{-1}. The result show little sensitivity to choice of model for the initial distribut The case of spherical expansion in this stage displays somewhat better agreement with observations. The assumption that an adiabatic stage is not present is in sharp contradiction with the observational data. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 3, 508-14 (Nov.-Dec., 1960)].

18019 ON THE INTERPLANETARY MAGNETIC STORM: PIONEER V.
P.J.Coleman, Jr, C.P.Sonett and L.Davis, Jr.
J. geophys. Res. (USA), Vol. 66, No. 7, 2043-6 (July, 1961).

During a period of intense solar activity between March 26 April 6, 1960, measurements of the magnetic fields in interplane ary space were obtained with the space probe, Pioneer V. The measured component of the fields, associated with the solar plas ejected during this period, attained strengths of 40 or more gam (compared to an average value of 2.7 gammas during normal periods). It is argued that these comparatively high fields existe in interplanetary space for many hours. From estimates of the plasma velocity, the radial extent of these regions of high field i calculated to be 0.7 AU. The fields associated with these region were observed to be quite regular. Similar results accompanied most of the more intense solar activity during the flight of Pione Possible implications of these results are discussed.

18020 SIZE AND MASS DISTRIBUTION OF COSMIC DUST. T.Laevastu and O.Mellis.
J. geophys. Res. (USA), Vol. 66, No. 8, 2507-8 (Aug., 1961).

The size distribution of the cosmic spherules found in sediments shows that the total mass of particles in equal size (diameter) intervals remains constant. The size distribution of cosmic dust in space, as computed from the data obtained by im measurements by artificial satellites, shows the same distributi in the interval of particle diameters approximately 5 μ and 15 μ, as determined by indirect extrapolation the distribution is proba valid for larger particles.

18021 VARIATIONS IN THE ROTATION OF THE EARTH ASSOCIATED WITH THE SOLAR FLARES OF FEBRUARY 23, 1956 AND JULY 10-14-16, 1959. A.Danjon.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 5-7. In French.

An abrupt discontinuity in the earth's rate of rotation was observed to occur towards the end of July, 1959, and was similar to that coinciding with the solar flare disturbance of February 23 1956. Both discontimuities are attributed to the effects of solar corpuscular streams entering the earth's upper atmosphere.
D.R.Bar

18022 COMPARISON OF TIME DETERMINED BY THE ROTATION OF THE EARTH WITH TIME OBTAINE FROM ATOMIC FREQUENCY STANDARDS. C.J.A.Penny.
"July 1959 Events' Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 7-10.

The results of two wholly independent comparisons between time determinations made photographically (PZT), and by means of two separate atomic frequency standards (NPL, Greenwich: NRL, Washington) are discussed. The comparisons cover the period, 1956-1960, the Greenwich PZT observations being compared directly with the Cs clock at the NPL, whilst the Washington PZT observations were compared with the NRL Atomichron clock. Between February 1959 and March 1960, the Greenwich and Washington time scales remained similar to with ±2 msc. From 1959 onwards, the terrestrial rotation-rate r ained sensibly constant; and there was no evidence of the d ontinuity reported by Danjon (see preceding abstract).

D.R.Barber

3023 DETERMINATION AND SURVEY OF PERIODIC TROJAN ORBITS IN THE RESTRICTED PROBLEM OF T EE BODIES. E.Rabe.

A on. J. (USA), Vol. 66, No. 9, 500-13 (Nov., 1961).

For the plane restricted problem of three bodies, new c putational and iteration methods were employed to determine, on ar M 650 electronic computer, a series of periodic orbits of the T an type. The resulting periodic solutions, established to a high de ee of numerical accuracy, refute Thüring's (1951, 1952, 1959) re ated claims of their nonexistence. Harmonic analysis was used to tain the Fourier series representation of all the orbits. The c ergence of the Fourier expansions is very satisfactory up to ar itudes of the order of those of the actual Trojan planets with th argest libration amplitudes. All the orbits computed appear to be able, even the horseshoe-shaped periodic orbit enclosing both ec ateral points and the collinear libration point opposite to Ju er. The latter class of orbits, anticipated by Brown (1911), is of rticular interest, because with their increasing amplitudes but de easing periods these orbits link the equilateral points with the sa lite region of Jupiter.

8024 THE EXPLICIT EXPRESSION FOR FIRST-ORDER SECULAR PERTURBATIONS IN TERMS OF THE O IT ELEMENTS. M.S.Yarov-Yarovoi.

A on. Zh. (USSR), Vol. 37, No. 4, 764-77 (July-Aug., 1960).
In ssian.

Explicit expressions for first-order secular perturbation are in stigated by means of a general expansion (according to N comb's method (1895)) into a power series in eccentricity and si of one-half the relative inclination of the orbits. An analysis of e number of terms in these expressions showed that the secular pe rbations can be calculated just as rapidly by means of an ytical formulae as by the Halphen—Goryachev method (1937). H ever, the propsed method has the advantage that harmonic an ysis does not have to be applied, and that it gives a possibility of es nating the residual terms. Besides, the perturbation function is ex nded into series averaged over only the mean anomaly of the pe rbing planet, or only the mean anomaly of the perturbed planet, an lso according to the Hill—Delauney scheme. As an example, th irst-order secular perturbations of the elements of Ceres pr uced by the eight large planets are calculated. The numerical va es of secular perturbations obtained are very close to those de ved by Proskurin (1952) and K.Merfield (1906-7). The secular pe rbation are also found empirically. In distinction from previous in stigations in this field, besides secular perturbations of the el ents $\underline{i}$, ω, Ω, the secular perturbation of the mean anomaly M, na g a coefficient Δn, is calculated. As a result, it is found that se lar perturbations determined empirically coincide within the li s of error with the first-order secular perturbations derived fr analytical formulae. [English translation in: Soviet A on.—AJ (USA), Vol. 4, No. 4, 722-34 (Jan.-Feb., 1961)].

8025 ANALYSIS OF INEQUALITIES IN THE EARTH'S ROTATION. II. THE PROGRESSIVE VARIATION AND T PERIOD OF ROTATION. A.Danjon.

C . Acad. Sci. (France), Vol. 252, No. 16, 2343-8 (April 17, 1961).
In rench.

For Pt I, see Abstr. 10303 of 1961. A careful discussion of the diffe- r e between the time as determined astronomically and from atomic st dards. Observations from Paris, Herstmonceux, Washington an Neuchâtel, corrected for short period inequalities (in particular th nnual term), are considered for the period 1956-60. In all ca s, a cusp on the graph indicates a sudden change in the length of e day of 0.79 ms on about 20 July, 1959. G.A.Chisnall

8026 ANALYSIS OF INEQUALITIES IN THE EARTH'S ROTATION. III. EXAMINATION OF A NEW H OTHESIS; CONCLUSION. A.Danjon.

C . Acad. Sci. (France), Vol. 252, No. 19, 2779-84 (May 8, 1961).
In rench.

Two hypotheses concerning the July 1959 event are investi- g d. Hypothesis A supposes the annual term (as defined in I) to e about the same from year to year. The 1959 event is then u sual and implies a sudden change in the length of the day, w ch appears to be synchronous with solar eruptions of exceptional im ortance. Hypothesis B assumes that the length of the day is not subject to sudden changes but ascribes the 1959 event to an anomaly in the annual term. Markowitz's (Report to C.O.S.P.A.R. on the Rotation of the Earth and the July, 1959 Event, 4 April, 1961).

G.A.Chisnall

18027 EFFECT OF THE SOLAR ACTIVITY ON THE EARTH'S ROTATION. H.Uyeda, Y.Saburi and H.Iwasaki.

J. Radio Res. Lab. (Japan), Vol. 7, No. 31, 131-6 (May, 1960).

Several years, covering the period from sunspot minimum to sunspot maximum, have passed since the beginning of the atomic frequency standard operation. During this period, comparing the trend of the monthly values of d(Cs-UT2)/dt, i.e. the time rate of difference of two standard times, atomic time and universal time, with that of the corresponding monthly values of the sunspot number R, it has been found that there exists a fine linear relation between them on their twelve-month running averages. This fact suggests that the earth's rotation on its axis is also influenced by the solar activity. The mechanism of the influence is considered to be very complex, but, as seen from a similarity between the monthly changes of individual monthly values of d(Cs-UT2)/dt and the characteristic figures of the earth's magnetism and ionosphere, it seems to be mainly due to the reaction upon the earth's rotation of space extending from the earth's surface to the sun. Some discussion is given to the difference between the frequency changes of individual atomic frequency standards.

18028 SPECTROPOLARIMETRY OF SOME REGIONS OF THE LUNAR SURFACE. V.G.Teifel'.

Astron. Zh. (USSR), Vol. 37, No. 4, 703-8 (July-Aug., 1960).
In Russian.

Spectropolarimetric observations of the moon at near quadrature reveal that the degree of polarization of lunar features falls off with wavelength in the spectral interval 400 to 620 mμ, by an average of 0.04-0.06. The variation of polarization with wavelength is determined chiefly by the dependence of polarization on the monochromatic albedo values of lunar formations, which is similar to the dependence of polarization on albedo in white light. But the polarization values obtained from observations over different intervals of the spectrum give some indication of being affected by the luminescence of lunar rocks. [English translation in: Soviet Astron—AJ (USA), Vol. 4, No. 4, 669-73 (Jan.-Feb., 1961)].

18029 THE COLOUR OF THE BRIGHT RAYS ON THE LUNAR SURFACE. L.D.Radlova.

Astron. Zh. (USSR), Vol. 37, No. 6, 1053-5 (Nov.-Dec., 1960).
In Russian.

The colour distribution along some bright rays, belonging to the systems of the craters Tycho, Copernicus, and Kepler, was studied by methods of visual and photographic colorimetry. For some rays a very insignificant variation of colour along the ray is found. However, the detected differences in colour are within the limits of errors of measurements and therefore it can be assumed that in the mean the layer of the bright rays is of the same colour as the surrounding background of the lunar surface. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 6, 990-2 (May-June, 1961)].

18030 METHODS OF DETERMINING THE POSITION OF THE MOON RELATIVE TO THE STARS. G.A.Plyugin.

Astron. Zh. (USSR), Vol. 38, No. 2, 345-60 (1961). In Russian.

In determining the position of the moon from photographs, measurement are made of points on the limb in a polar coordinate system. Three different methods of assigning the origin of the polar coordinate system are investigated: (1) by an artificial mark; (2) by means of a stencil in the shape of a ring encircling the moon's image; and (3) by the centre of rotation of the position circle of the Sukharev coordinate-measuring machine. It is found that the precision attained is about the same in all three cases, and equals 1.0-1.5μ. The position of the moon's centre is determined by measuring plates on the Sukharev measuring machine, taking the centre of rotation of its position circle as the origin of the polar coordinate system. The results obtained confirm the possibility of assigning the origin of the polar coordinate system in this way. A question which arises when measuring photographs of the moon is the influence of the relief of the limb on the coordinates of the moon s centre. At present, no charts exist which give the actual "large relief" of the moon's limb. In determining the moon's position by photography, there is no need therefore to introduce corrections from existing charts for irregularities in the profile of the moon's limb. But the number of measured points on the moon's limb should be increased from 30 to 50-60, in order to reduce random errors in the coordinates of the centre arising from the micro-relief of the limb. In some of the photographs, the moon's limb is very diffused, the horns and the middle of the illuminated limb being affected quite differently. It is therefore necessary to make a strict selection of the plates for measurement according to previously established criteria, since otherwise, a large systematic error in the moon's coordinates of the order of 1" can arise on some of the plates. [English translation in: Soviet Astron.—AJ (USA), Vol. 5, No. 2, 255-66 (Sept.-Oct., 1961)].

18031 THE PHOTOGRAPHY OF THE REVERSE SIDE OF THE MOON — TECHNIQUES AND PRELIMINARY RESULTS.

Yu.N.Lipskii.
Astron. Zh. (USSR), Vol. 37, No. 6, 1043-52 (Nov.-Dec., 1960).
In Russian.

The method used for studying the photographs of the reverse side of the moon is described. The photographs were taken by means of an automatic circumlunar station on October 7, 1959. Some of the results obtained are given. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 6, 976-89 (May-June, 1961)].

18032 ON THE POSSIBLE PRESENCE OF ICE ON THE MOON.

K.Watson, B.Murray and H.Brown.
J. geophys. Res. (USA), Vol. 66, No. 5, 1598-1600 (May, 1961).

Contrary to existing beliefs regarding the presence of lunar atmospheric H_2O, it is here suggested that H_2O (as ice) will, in fact, be far more stable than either SO_2, or other gaseous compounds, both of which have been postulated (Kuiper 1952) and (Urey, 1952). This follows from a knowledge of the extremely low vapour pressure of H_2O at sub-zero temperatures. Consequently, the maximum pressure of water vapour that can exist permanently over the lunar surface will be many orders of magnitude lower than the corresponding pressures of SO_2, or the rare gases. At 120°K the computed pressure will be 1.1×10^{-11} g cm^{-2}, thus yielding a total lunar atmospheric H_2O content of 4.2×10^6 g. The above values are consistent with recent results from radio-occultation measurements (Elsmore, 1957). D.R.Barber

18033 THE LUNAR NEUTRON FLUX.

R.E.Lingenfelter, E.H.Canfield and W.N.Hess.
J. geophys. Res. (USA), Vol. 66, No. 9, 2665-71 (Sept., 1961).

The equilibrium neutron-leakage spectrum at the lunar surface and the neutron capture as a function of depth beneath the surface were calculated for a number of assumed lunar surface compositions. The leakage spectrum is found to be particularly sensitive to hydrogen abundance; an experiment is accordingly proposed to determine the hydrogen content of the lunar surface by neutron flux measurements near the moon.

18034 THE BEHAVIOR OF VOLATILES ON THE LUNAR SURFACE. K. Watson, B.C.Murray and H.Brown.

J. geophys. Res. (USA), Vol. 66, No. 9, 3033-45 (Sept., 1961).

Volatiles, and water in particular, have been thought to be unstable on the lunar surface because of the rapid removal of constituents of the lunar atmosphere by solar radiation, solar wind, and gravitational escape. The limiting factor in removal of a volatile from the moon, however, is actually the evaporation rate of the solid phase, which will be collected at the coldest points on the lunar surface. A detailed theory of the behaviour of volatiles on the lunar surface is presented based on solid—vapour kinetic relationships, and water is shown to be far more stable there than the noble gases or other possible constituents of the lunar atmosphere. Numerical calculations indicate the amount of water lost from the moon since the present surface conditions were initiated is only a few grams per square centimetre of the lunar surface. The amount of ice eventually detected in lunar "cold traps" thus will provide a sensitive indication of the degree of chemical differentiation of the moon.

18035 SMALL-SCALE EXPLOSION CRATERS, IMPACT CRATERS, AND THE PHYSICAL STRUCTURE OF THE MOON'S SURFACE. G.Fielder.

Monthly Not. Roy.Astron. Soc. (GB), Vol. 123, No. 1, 15-26 (1961).

A comparison of the forms of experimental explosion craters and the observed forms of lunar craters leads to the conclusion that parts of the moon may be covered with a layer of material, having the physical properties of a gravel, to a depth of between 0.3 km and 1-3 km. Predictions are given for the variation of the ratio of the depth of a crater to its diameter, as the diameter varies, for likely models of the moon's surface layers, and an elementary but cri type of lunar observation, which may be of great assistance in identification of the broad physical nature of these layers at di points on the moon, is described. Both explosion-experiments, experiments involving non-explosives, indicate that the lunar-r were ejected from craters at relatively low angles, and that th probably consist of small, secondary craters and many more s bright particles. The primary ray-craters were probably prod by near-surface meteoritic impacts in which explosive-type vio and crushing both played parts. In the small secondary craters velocities only ~ 1 km/sec, crushing would predominate, and th hypothesis is supported by the fact that the rays extending from these small craters are unidirectional. Conditions for dome-fo tion are stipulated. If domes and conical craters are found to c together on the moon, then the domes are probably igneous phen ena rather than the surface effects of camouflets. Experimenta conditions required for the formation of craters with central eminences are described, and photographs of bomb craters and explosion craters in lead are compared with the lunar craters. Both small-scale and lunar-size craters often display approxim radial patterns outside their walls, and these patterns indicate that the stresses associated with their formation were of simila type and distribution on the two different scales.

18036 HOLISTIC APPROACH TO SELENOLOGY.

B.Warner.
Nature (GB), Vol. 191, 586 (Aug. 5, 1961).

The author stresses the need for more detailed informatio regarding the features of the moon's surface before developing contemporary selenological theories more fully. None of the existing theories takes into account the fact that primary surfac features have been altered considerably by secondary action su as stress systems and erosion. Moreover, many recently disc surface details do not fit in with any of the contemporary theories G.R.Gre

18037 NON-HYDROSTATIC TENSIONS IN A GRAVITATIN PLANET. G.Jobert.

C.R.Acad. Sci. (France), Vol. 253, No. 10, 1163-5 (Sept. 4, 1961
In French.

It is supposed that a planet was developed by the capture of solid particles in such a way that the density at a distance r fro the centre is always of the form $\rho_1 f(r)/f(x)$, where x is the radiu From consideration of the stresses in newly formed surface lay an expression is obtained for the difference between the radial transverse stress as a function of r and x. The result is used t estimate the maximum differential stress in the case of the mo R.A.Ne

18038 DENSITY IN A PLANETARY EXOSPHERE.

J.Herring and L.Kyle.
J. geophys. Res. (USA), Vol. 66, No. 6, 1980-2 (June, 1961).

Comment on the recent theory of Öpik and Singer (Abstr. 8 of 1960), by the use of which the ballistic component of the neut density distribution in a planetary outer atmosphere may be de It is stressed on theoretical grounds that both the ionized and b orbit components must be included also in any complete descrip of a planetary exosphere. D.R.Ba

18039 SOME REMARKS ON THE DUST AND HAZE FORMATIONS ON MARS.

N.P.Barabashov and V.I.Garazha.
Astron. Zh. (USSR), Vol. 37, No. 3, 501-7 (May-June, 1960).
In Russian.

Inferences based on an examination of the brightness distr tion curves during the 1956 opposition and the rearward portion indicatrices are drawn as to the structure of the Martian solid surface, and as to the properties of the yellow clouds and mist often appear in the Martian atmosphere. [English translation in Soviet Astron.—AJ (USA), Vol. 4, No. 3, 473-9 (Nov.-Dec., 1960)

18040 A LITHOLOGICAL INTERPRETATION OF THE PHOTOMETRIC AND COLORIMETRIC STUDIES O MARS. V.V.Sharonov.

Astron. Zh. (USSR), Vol. 38, No. 2, 267-72 (1961). In Russian.

The results of visual photometric and colorimetric observa tions of the surface of Mars, made during 1956 and 1958, were compared with data of a similar sutdy of a large number of samples of terrestrial rocks. It was found that, according to th mean values of the albedo r and the colour excess D, sand and

materials covering deserts on the earth, the red rocks of the
ian system, and the dense varieties of limonite are not
ar to the continents of Mars, as the red colour of the latter is
derably more saturated. Only the ochres, i.e., earthy varieties
ıonite, are approximately similar in colour to the disc of Mars.
efore, the hypothesis is proposed that the surface of the
an continents is everwhere covered with silt consisting of
fine particles of limonite. The latter, ascending into the
phere, produce the orange haze, the development of which
haracteristic of the opposition of 1956. [English translation
oviet Astron —AJ (USA), Vol. 5, No. 2, 199-202
-Oct., 1961)].

041 MEASUREMENT OF THE RADIAL VELOCITY OF VENUS BY ELECTRONIC PHOTOGRAPHY.
chesne, L.Gallouet and B.Guinot.
Acad. Sci. (France), Vol. 253, No. 4, 613-14 (July 24, 1961).
ench.
description is given of an interferometric—spectrographic
d for evaluating the constant of aberration from spectra of
and the sun. A Fabry—Perot etalon is used in front of the
rograph slit, and the consequent large increase of exposure is
ed by using a Lallemand camera for recording the spectra.
al spectrograms are reproduced. D.R.Barber

3042 THE AEOLOSPHERE AND ATMOSPHERE OF VENUS.
E.J.Öpik.
ophys. Res. (USA), Vol. 66, No. 9, 2807-19 (Sept., 1961).
self-consistent model of the Venus atmosphere that satisfies
ultitude of existing observational data is proposed. Its main
rties and the line of reasoning are described as follows. The
tive greenhouse effect cannot account for a surface temperature
0° K. The blanketing must be due to dust; and the main source
ergy, wind friction at the surface. The term "aeolosphere" is
sed for the region between the surface and the clouds of
s, where wind is reponsible for grinding and raising the dust
ll as for the heating. Self-consistency requires the opacity
so high as to impose an adiabatic vertical lapse rate. The
tial temperature in the aeolosphere must be nearly constant.
ontal pressure gradients driving the wind are caused by
tic differences near the top of the dust clouds. The dust may
st of calcium and magnesium carbonates with impurities.
sure estimates from CO_2 bands and optical scattering point to
resence of two distinct reflecting layers, the visible cloud level at
0.6 atm and 340° K, and an upper haze level at 0.08 atm and 234° K.
visual and near infrared the upper haze is virtually trans-
t, owing to forward scattering. In the ultraviolet, and in the
red beyond 1.4 microns, it is opaque. Vertical cross-sections
Venus atmosphere are constructed for 80, 40, and 20% CO_2.
0% CO_2 the results are somewhat more consistent, yielding a
ure of 4.3 atm at 570° K at the surface, 22 km below the
e cloud level. Despite uncertainties in the H_2O content, its
nt is so small as to be nowhere condensable.

043 ORIGIN OF RAPIDLY ROTATING ASTEROIDS.
E.L.Ruskol and V.S.Safronov.
n. Zh. (USSR), Vol. 38, No. 2, 273-7 (1961). In Russian.
paper by Rabe (Abstr. 6571 of 1960) is discussed. It is
n that the process proposed therein, of the origin of rapidly
ing asteroid systems, has an extremely small probability.
ish translation in: Soviet Astron.—AJ (USA), Vol. 5, No. 2,
(Sept.-Oct., 1961)].

044 SYMPOSIUM ON COMETS.
Astron. J. (USA), Vol. 66, No. 8, 361 (Oct., 1961).
The Symposium was sponsored by the American Astronomical
ty and the Maria Mitchell Observatory, with the support of
ational Science Foundation. It was held on 20 June, 1961 in
cket, Massachusets. Titles of the six papers presented at
ymposium follow below.

045 STRUCTURE AND DEVELOPMENT OF THE GAS TAILS OF COMETS. K.Wurm.
n. J. (USA), Vol. 66, No. 8, 362-7 (Oct., 1961).

46 ASTROMETRIC OBSERVATIONS AND ORBITS OF COMETS. E.Roemer.
n. J. (USA), Vol. 66, No. 8, 368-71 (Oct., 1961).

047 PHOTOELECTRIC PHOTOMETRY OF COMETS.
W.Liller.
n. J. (USA), Vol. 66, No. 8, 372-4 (Oct., 1961).

18048 PROBLEMS OF THE COMETARY NUCLEUS.
F.L.Whipple.
Astron. J. (USA), Vol. 66, No. 8, 375-80 (Oct., 1961).

18049 THE SURVIVAL OF COMETS AND COMETARY MATERIAL. E.J.Öpik.
Astron. J. (USA), Vol. 66, No. 8, 381-2 (Oct., 1961).

18050 NEW INVESTIGATIONS ON THE C_3 SPECTRUM AT 4050 A. B.Rosen.
Astron. J. (USA), Vol. 66, No. 8, 383 (Oct., 1961).

18051 ORBIT OF COMET 1948 I (BESTER).
G.Van Biesbroeck.
Astron. J. (USA), Vol. 66, No. 8, 424-9 (Oct., 1961).

The computation is based on 243 measures of position covering the period from 141 days before to 356 days after perihelion. Planetary perturbations were taken into account but remained small. The hyperbolic excess comes out 48 times its probable error. The "original" orbit, however, turns out to be a very large ellipse.

18052 THE FORM OF COMETARY ENVELOPES.
L.S.Marochnik.
Astron. Zh. (USSR), Vol. 37, No. 3, 508-12 (May-June, 1960).
In Russian.

Alfvén's hypothesis relating to the interaction between cometary gas and a stream of particles carrying a magnetic field [Tellus (Sweden), Vol. 9, No. 1, 92-6, (Feb., 1957)] is used to show that the form of a cometary envelope is described by a catenary, in accord with observations. The parabolic relationship following from the mechanical theory of cometary forms is only a rough approximation. The transverse motions observed in the tails of comets are accounted for in terms of Alfvén waves. The upper limit of the magnetic field is estimated. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 3, 480-4 (Nov.-Dec., 1960)].

18053 PARTIAL GAS DENSITIES IN COMET 1942g WHIPPLE.
B.A.Vorontsov-Vel'yaminov.
Astron. Zh. (USSR), Vol. 37, No. 4, 709-15 (July-Aug., 1960).
In Russian.

The absolute monochromatic emission of the comet in the bands CN 3883, C_2 4730, and C_3 4050 was found by reference to stellar spectra, using a spectrogram obtained with an objective prism, by Tevzadze on March 11, 1943. Inside the isophote equal to 0.05, at a radius of the coma of 15' or 3.7×10^5 km, the number of molecules were determined: 1.3×10^{33}, 7.1×10^{32}, and 2.7×10^{31}, respectively. The mass of the coma as a whole was found to be 8×10^{10} gm. The densities varied inversely as the square of the distance from the nucleus. Near the nucleus they were of the order of 10^{11} molecules, and at a distance of 3.7×10^5 km, about 2 CN molecules, 1 C_2 molecule, and 0.04 C_3 molecules per cm^3. The number of molecules calculated from visual brightness according to Zanstra's method (1929) is of an order close to that derived by the precise spectrophotometric method. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 4, 674-9 (Jan.-Feb., 1961)].

18054 OBSERVATION OF COMETS. I. PHOTOGRAPHIC OBSERVATION OF THE AREND—ROLAND (1956 h) COMET. P.Maffei.
Mem. Soc. Astron. Ital., Vol. 32, No. 1, 55-74 (1961). In Italian.

96 plates of the 1956 h comet were obtained from 20 January to 26 December 1956, with the 24 inch Zeiss reflector of the Astronomical Station at Loiano. Values of the position angle of the tail, some essential characteristics of the tail and of the head, and the variations of the structure of both, were determined. The tail showed a double structure in the form of corpuscular and gaseous components from 21 May to 26 June. Shape and length of the gaseous tail are similar to that observed in January and February 1957. During the night from 4 to 5 May a rapidly moving configuration was photographed. A velocity of 53 Km/s and an acceleration of 75 cm sec^{-2} were derived. Further researches about a possible relation of this with solar phenomena yielded a negative result.

18055 OBSERVATION OF COMETS. II. PHOTOGRAPHIC OBSERVATION OF COMET MRKOS (1957 d). P.Maffei.
Mem. Soc. Astron. Ital., Vol. 32, No. 1, 75-84 (1961). In Italian.

From 14 August to 27 September, 71 plates of comet Mrkos (1957 d) were taken with the 60 cm Zeiss reflector of the Astronomical Station at Loiano. The comet showed two tails, one of which was rectilinear and of a gaseous nature and exhibited continuous variations. On the days of 16, 17, 21, 27 and 31 August some configurations in motion were followed, from which accelerations between 24.4 and 101.8 cm sec^{-2} were derived. The examination of the plates taken with different light filters permitted a qualifying comparison of the diameters and shapes of the head in various colours.

18056 C_2, CN AND CO^+ MOLECULAR DENSITIES IN THE ATMOSPHERES OF BRIGHT COMETS. K.Wurm.

Z. Astrophys. (Germany), Vol. 52, No. 4, 285-93 (1961). In German.

18057 RESULTS OF A STUDY OF PHOTOGRAPHS OF THE BOLIDE OF MAY 11, 1955. E.N.Kramer.

Astron. Zh. (USSR), Vol. 37, No. 4, 736-45 (July.-Aug., 1960). In Russian.

Photographs of a bright bolide, the visual magnitude of which reached -10^m, were obtained with two astrocameras of the Odessa Observatory on May 11, 1955 at $22^h43^m24^s$ (Moscow time). The bolide apparently belonged to the radiant (248°.5, -13°.9), discovered previously by McIntosh (1935). Its trajectory, which was photographed at heights from 107 to 75 km, deviated slightly from a linear trajectory, and at a height between 92 and 80 km divided into two. This division was the result of an internal explosion of the meteor body, two fragments of which acquired an initial velocity of about 200 msec^{-1}, and can be considered analogous to explosions in cometary nuclei during the formation of meteor streams. The periodic fluctuations in the brightness of the bolide are explained by processes of periodic formation and throwing off of an "air-cap", which develops in the earth's atmosphere in front of the moving meteor body. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 4, 696-704 (Jan.-Feb., 1961)].

18058 I—Xe DATING OF METEORITES. J.H.Reynolds.

J. geophys. Res. (USA), Vol. 65, No. 11, 3843-6 (Nov., 1960).

The Richardton stone has a large excess of Xe^{129}, mostly deriving from I^{129} incorporated at the time of meteorite formation. In order to find the I^{127}/Xe^{129*} ratio, where Xe^{129*} is the Xe^{129} attributed to iodine decay, a mass-spectrometric analysis of the xenon from two pieces of the stone was made after irradiation of the samples with thermal neutrons. To calibrate the production of Xe^{128} from I^{127} via I^{128} during irradiation, samples of KI were irradiated at the same time. The ratios obtained, $(2.5 \pm 0.4) \times 10^5$ and $(1.02 \pm 0.11) \times 10^5$, are about an order of magnitude less than previous estimates which assumed 1 p.p.m. I content in chondrites. It is suggested that in the formation of the solar system from cold gas and dust, the condensation phase was short — about 10^8 years.

D.M.Gilbey

18059 SPACE EROSION OF THE GRANT METEORITE. D.E.Fisher.

J. geophys. Res. (USA), Vol. 66, No. 5, 1509-12 (May, 1961).

An upper limit to the erosion of iron meteorites in space is calculated, based on the cosmic exposure age of the Grant meteorite and the measured depth variation of cosmogenic Ne^{21} in this meteorite. A value for E_{max} of $\sim 1.1 \times 10^{-8}$ cm yr^{-1} is found. A previous estimate based on the Sikhote—Alin meteorite is discussed.

18060 COSMOGENIC ARGON AND NEON IN STONE METEORITES. H.Stauffer.

J. geophys. Res. (USA), Vol. 66, No. 5, 1513-22 (May, 1961).

The abundance and isotopic composition of argon and neon in six chondrites and an achondrite were measured. The results of previous investigations are confirmed, namely A/K ages from 1.3 to 4.6 billion yr and exposure ages from 4 to 24 million yr. It is shown that the differences of the ratios A^{36}/A^{38} are due mainly to small amounts of trapped primordial or atmospheric argon. Using the corrected A^{38} abundances, a value of 9.0 with a total spread of ±20% is found for the corrected Ne^{21}/A^{38} ratios. The possibility of diffusive losses of cosmogenic rare gases is discussed.

18061 THERMOMAGNETIC PROPERTIES, NATURAL MAGNETIC MOMENTS, AND MAGNETIC ANISOTROPIES OF SOME CHONDRITIC METERORITES.

F.D.Stacey, J.F.Lovering and L.G.Parry.

J. geophys. Res. (USA), Vol. 66, No. 5, 1523-34 (May, 1961).

Thermomagnetic analyses, thermal demagnetization of natural and laboratory-induced remanent magnetic moments, and measurements of magnetic anisotropy were carried out on a number of chondritic stony meteorites. 80-90% of the saturation magnetic moments were due to α-phase Fe—Ni (kamacite) containing 5- Ni, and this phase was also responsible for most of the observ remanence and magnetic anisotropy. Minor magnetic constitu were determined with much less certainty. The natural magne moments of the Mt. Browne, Homestead, and Farmington chon had two components of quite different origins; in each case the important component appears to have been induced thermally i extraterrestrial field. The Mokoia carbonaceous chondrite wa found to have only a small moment, consistent with isothermal induction in the earth's field. The magnetic anisotropies of ei chondrites were found to be related to the degree of metamorp indicated by their porosities. The magnetic evidence is consis with the supposition that the chondrites once formed parts of t mantle of a body with a fluid metal core which produced a mag field of terrestrial type.

18062 REMARKS ON THE ARTICLE BY A.R.HIBBS, "TH DISTRIBUTION OF MICROMETEORITES NEAR T EARTH". M.Dubin.

J. geophys. Res. (USA), Vol. 66, No. 8, 2592-4 (Aug., 1961).

In a recent article by Hibbs (Abstr. 15297 of 1961) it is postulated that data on the impact rate of micrometeorites obtained from the Explorer I flight (1958) suggest: (1) an altitu dependence; and (2) the presence of particles moving in trappe orbits around the earth. Further analysis of the same data by the present author yields insufficient evidence with which to co firm either of the above suggestions.

D.R.Ba

18063 AUTHOR'S REPLY TO THE PRECEDING DISCUSS ON THE ARTICLE "THE DISTRIBUTION OF MICR METEORITES NEAR THE EARTH". A.R.Hibbs.

J. geophys. Res. (USA), Vol. 66, No. 8, 2595-6 (Aug., 1961).

In reply to Dubin's comment (see preceding abstract) it is pointed out that, from a re-examination of the Explorer I data, after deletion of the high impact-rates associated with the parti "shower" on February 2-3, 1958, both altitude dependence, and closed-orbit features are still present. However, because of th reduced number of total hits included in the new analysis, the statistical validity of the above conclusions is less certain.

D.R.Ba

18064 THE IDENTIFICATION OF METEOR SHOWERS WI APPLICATION TO SOUTHERN HEMISPHERE RESULTS.

C.Ellyett, C.S.L.Keay, K.W.Roth and R.G.T.Bennett.

Monthly Not. Roy. Astron. Soc. (GB). Vol. 123, No. 1, 37-50 (19

Meteor shower results observed by radar at Christchurch, New Zealand, are given, including results at high rates, and all Christchurch data are compared with visual observations, and radar results from Adelaide, for the declination range from +2 to about -50°. Seven meteor showers appear in all three surve and can be regarded as certain, and another 6 to 9, which are e reported twice, are probable. An additional 9 to 10 radiants, ho ever, are found by each survey alone. The errors inherent in t identification of meteor showers from radar data are considere Different techniques have been used at Christchurch and at Adel It is concluded that no single method of analysis is fundamentall better than any other. The technique of shower identification de partly on the nature of the background rate, which may be due e to sporadic meteors, or to the resultant of many minor radiants The resolution of this uncertainty is necessary before the occur of less active showers can be confirmed. The rate-count metho was extended to multiple range bands, resulting in a useful addi means of sorting out the significance of peaks in the rate curve

18065 PHYSICAL THEORY OF METEOR. M.Nomoto.

Sci. Rep. Tohoku Univ. First Ser. (Japan), Vol. 43, No. 4, 245-5 (Dec., 1959).

The action of the atmosphere against a meteor is studied b treating the impact of individual atoms and molecules of the atm phere on the meteor surface, causing successively a process of radiation damage on the inside of the meteor surface, and the av age of the heat-transfer rate over the meteor surface is estimat to be about 0.81, assuming that the surface is roughly spherical Assumung that the medium of the meteor is continuous and mak use of Mitra's data for the atmosphere density [S.K.Mitra. The upper atmosphere (1952). Chapter XIII] variations of the meteo velocity, radius amd temperature against height are found as fu tions of the initial velocity, dimension and angle of incidence. T appearance and disappearance heights are estimated as function ame initial quantities. The results found for the appearance isappearance heights are quite reasonable in comparison with bserved data.

1066 CONCERNING Xe^{129} IN THE METEORITE ABEE.
P.M.Jeffery and J.H.Reynolds.

aturforsch. (Germany), Vol. 16a, No. 4, 431-2 (April, 1961).

The evolution of A and Xe isotopes was measured as a ıle of the meteorite Abee was heated to successively higher eratures. The results are in broad agreement with those of inger and Gentner (Abstr. 9262 of 1961). There were, however, :ed fluctuations with temperature of the Xe^{129}/Xe^{132} ratio, esting the presence in the meteorite of Xe^{129}-rich phases. The is possibly the daughter of I^{129} contained in a sulphide phase. D.M.Gilbey

3067 A NOTE ON THE ORIGIN OF THE SUN'S POLAR FIELD. F.Hoyle and N.C.Wickramasinghe.

hly Not. Roy. Astron. Soc. (GB), Vol. 123, No. 1, 51-9 (1961).

A process is described whereby the sun's polar field can be up from comparatively small-scale magnetic loops carried ards by particle streams. The reversal of the general polar is associated with a reversal of the sense of the loops that dle the solar equator.

3068 A HYDROMAGNETIC MODEL OF THE SOLAR MAGNETIC FIELD. I.K.Csada.

. Soc. Roy. Sci. Liege (Belgium), Sér. cinquième, Vol. III, 52 (1960).

The external solar magnetic field can be represented by the ır potential

$$A\varphi = \frac{h_1P_1}{r^2} + \frac{h_3P_3}{r^3}$$

ıy the superposition of a dipole and an octupole field. (DO ɪl). Using the Babcock magnetograms, values of the magnetic H_x, in the line of sight have been obtained. Corresponding es of H_x derived from $A\varphi$ gives a value of $h_3/h_1 = 0.4r_{\odot}^2$ by using ıethod of least squares. A mean value of $h_3/h_1 = 0.386r_{\odot}^2$ was ned from the form of the coronal polar rays at sunspot mum. Extrapolation of the results down to the equator shows a bundle of lines of force returns to the surface in the same sphere where they arose. The variation of h with time is also ıined and it is found that the polarity of the solar field should ge in the successive parts of a magnetic cycle. A description e "butterfly" diagram is also given. G.R.Greatrix

8069 A TIME DEPENDENT SOLAR MODEL.
A.N.Cox and R.R.Brownlee.

Soc. Roy. Sci. Liege (Belgium), Sér. cinquième, Vol. III, 78 (1960).

The Vogt—Russell theorem is only true if all the physical erties of the material depend on local conditions. One way to rmine a stellar model is to start with a composition distribution ts properties, and a total mass divided into concentric shells. rbitrary starting configuration can be relaxed by integrations ne which follow the physical conditions in each layer until a e configuration is reached. A configuration given by ymann (Abstr. 8362 of 1957) as a model for the present sun is ted in the above way. It is concluded that this method can uce stellar models, and that the Weymann solar model is not a one. The present difficulties are the outer layer convection he boundary condition. Future problems should be solved with than twenty concentric shells. G.R.Greatrix

8070 AN EVOLUTIONARY SEQUENCE OF SOLAR MODELS WITH REVISED NUCLEAR REACTION RATES.

Sears.

. Soc. Roy. Sci. Liege (Belgium), Sér. cinquième, Vol. III, 89 (1960).

In regions of high temperature and/or high helium to hydrogen the p—p chain may be completed more frequently through the $\alpha,\gamma)Be^7$ reaction than through $He^3(He^3, 2p)He^4$. In an evolution- sequence of stellar models in which both the central tempera- and the helium to hydrogen ratio are increasing with time, the t of the former reaction will become progressively more rtant. The energy generation formula is given and this is in constructing a sequence of models. A period of 8×10^9 yr is needed to evolve the model which most satisfactorily represents the present sun. The discrepancy between this age and the usually accepted age of 4.5×10^9 yr can be removed by making a slight change in the initial composition of the model. The changes needed are within the uncertainties of the spectroscopically determined composition. G.R.Greatrix

THE OPTICAL PHENOMENA FORMING A SOLAR CENTRE OF ACTIVITY. See Abstr. 18071

18071 THE OPTICAL PHENOMENA FORMING A SOLAR CENTRE OF ACTIVITY. K.O.Kiepenheuer.

"Solar radioastronomy", Varenna Summer School, 1959 (see Abstr. 15532 of 1961) p. 39-83.

This detailed synopsis of solar physical phenomena is based on the tacit assumption that all the observed variables — optical and radio — can be considered as constituents of a single complex centre of solar activity. The review includes observing techniques, and observational restrictions imposed by instrument, and terrestrial atmosphere. Descriptions of the optical phenomena cited are profusely illustrated. 23 references. D.R.Barber

18072 PHENOMENA ACCOMPANYING THE BIRTH OF SUNSPOT PORES. R.E.Loughhead and R.J.Bray.

Austral. J. Phys., Vol. 14, No. 3, 347-51 (Sept., 1961).

Disturbances in the photospheric granulation accompanying the birth and development of some sunspot pores are illustrated and described. The disturbances lasted for about 3 hr and took the form of a number of dark lanes lying between two groups of pores whose location with respect to the rest of the spot group suggests that they were of opposite magnetic polarities. The detailed process of the birth and development of one of the pores is also illustrated. The pore started as a dark area no larger than a single photospheric granule; subsequently it became darker and larger and coalesced with a pre-existing pore. Significant changes in shape and area took place within periods of half an hour. The phenomena described are interpreted as evidence of the existence of a rising loop of magnetic flux. The nature of the interaction between the rising field and the solar material is discussed with reference both to the present observations and to observations of the umbral granulation.

18073 THE POSSIBLE PERIODICITY OF SOLAR ACTIVITY. A.I.Ol'.

Astron. Zh. (USSR), Vol. 37, No. 2, 222-6 (March-April, 1960). In Russian.

Newcomb's hypothesis (1901) that there is a strict periodicity with a period of 11-13 yr underlying the solar-activity variations is verified, using more complete and recent data. The investigation shows the correctness of this hypothesis; the deviations of the observed epochs of the extrema of Wolf numbers from those computed on the basis of this hypothesis are not random, but depend on the general level of solar activity. Some of the derived correlations are used for the prediction of the epochs of minimum and maximum of the next 11-yr cycle of solar activity. See also following abstract. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 2, 212-16 (Sept.-Oct., 1960)].

18074 THE CIRCULATORY NATURE OF THE ELEVEN-YEAR CYCLE OF SOLAR ACTIVITY.

V.F.Chistyakov.

Astron. Zh. (USSR), Vol. 37, No. 3, 425-35 (May-June, 1960). In Russian.

An attempt is made to account for some of the features observed in the development of 11-yr cycles on the basis of Spörer's law, which is invoked as evidence of meridional circulation in the surface layer of the sun. Emphasis is laid on the fact that, despite different intensity levels, all of the cycles have many features in common, related to the latitude drift of sunspot zones: (a) the invariance of the shape of Spörer curves $\bar{\varphi}$ (t); (b) the possibility of matching the terminations of descending branches of the cyclic curves; (c) constant mean latitude of the zone at the end of a cycle, etc. Analysis of the cyclic migration of the N_{φ} curves of annual distribution of the number of sunspots in latitude makes it possible to determine the epoch of maximum for the cycle on the basis of Spörer's law, rather than on the basis of intensity parameters. The established fact of the slowing of meridional circulatory velocity at the end of the cycle is used to explain the difference in the duration of the ascending and descending branches of the cyclic curve. The totality of the available observational material is consistent with the circulatory model of cyclicity advanced by

Bjerknes. The rise of the cyclic curve is explained by the approach of the active zone to the surface, and the decline of the cyclic curve is explained by the recession of the active zone. The epoch of maximum in the cycle is a limiting epoch in this sense, marking off the ascent and descent of the active zone. See also preceding abstract. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 3, 405-14 (Nov.-Dec., 1960)].

18075 THE MECHANISM OF FORMATION OF ACTIVE REGIONS IN THE PRESENCE OF A MAGNETIC FIELD.

S.B.Pikel'ner.
Astron. Zh. (USSR), Vol. 37, No. 4, 616-21 (July-Aug., 1960).
In Russian.

Faculae, flocculi, and certain types of coronal rays are closely associated with magnetic regions. These phenomena may be the result of acceleration of movement in the upper layers of the convective zone. The energy dissipation of streams in these layers is due to turbulent viscosity. A weak field does not affect the main streams, but reduces turbulence, i.e., the flow becomes more stable. This decreases dissipation and increases convective velocity. Polar faculae are associated with the sun's polar magnetic field. The low field strength determines their brightness (they are faint), and the great depth of their upper boundary. Heating from polar faculae gives rise to the polar coronal rays and possibly the permanent solar wind. Complicated spectral variations in magnetic stars may also be associated with the influence of the field on convection. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 4, 590-4 (Jan.-Feb., 1961)].

18076 MERIDIONAL CIRCULATIONS IN THE HYDROGEN CONVECTIVE LAYER OF THE SUN. R.Kippenhahn.

Mem. Soc. Roy. Sci. Liege (Belgium), Sér. cinquième, Vol. III, 249-55 (1960).

In the absence of a magnetic field the large-scale motions in the hydrogen convective zone can be deduced from the present knowledge about its structure by considering only the hydrodynamic effects. It is found that the condition of hydrostatic equilibrium cannot be satisfied unless there exist meridional circulations. At the outer surface of the zone these circulations must flow toward the pole. When the viscosity is half way between the pure monotropic and the isotropic case the circulatory system has velocities of 1 m/sec in a radial direction and maximal surface velocities of 10 m/sec. The mechanism only applies to the higher latitudes, outside the sunspot zones, where one can observe the poleward motion of the filaments. G.R.Greatrix

18077 REMARKS ON THE DETERMINATION OF INTENSITIES IN THE WINGS OF STRONG FRAUNHOFER LINES.

W.Mattig and E.H.Schröter.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 7, 391-8 (1960). In German.

A theoretical treatment of the problem of evaluating the influence of wing-profiles on the observed centre-to-limb intensity variation in strong Fraunhofer lines. Data based on various solar model atmospheres is used to compute line profiles, which are compared directly with observational results. It is found that the amount of centre-to-limb variation obtainable from model profiles depends strongly on the particular solar model adopted.

D.R.Barber

18078 SECULAR VARIATIONS OF SHORT-LIVED SUNSPOTS.

T.S.Ringnes.
Nature (GB), Vol. 192, 151-2 (Oct. 14, 1961).

Based on an analysis of Greenwich Photo-heliographic Results, 1879-1957, it is shown that a large secular variation of the frequency of occurrence of short-lived sunspots exists. Frequency distribution of spots with respect to area is found to vary systematically from one 11 yr cycle to the next in such a way that the frequency maximum decreases with increasing area. D.R.Barber

18079 AN ATLAS OF THE INFRARED SOLAR SPECTRUM FROM 1 TO 6.5 μ OBSERVED FROM A HIGH-ALTITUDE AIRCRAFT.

J.T.Houghton, N.D.P.Hughes, T.S.Moss and J.S.Seeley.
Phil. Trans A (GB), Vol. 254, No. 1037, 47-123 (1961).

Records are presented of the infrared solar spectrum from 1 to 6.5 μ, observed from altitudes up to 15 km. A resolution of about 1 cm^{-1} was obtained over the whole region and 1200 absorption lines belonging to water vapour, CO_2, CO, N_2O and CH_4 were identified.

18080 SOLAR ACTIVITY IN 1960.

T.A.Cragg.
Publ. Astron. Soc. Pacific (USA), Vol. 73, 198-201 (June, 196

18081 A PRELIMINARY STUDY OF THE PRESENT CY
OF SOLAR ACTIVITY.

M.G.Fracastoro, R.Campisi, M.Catalano, S.Torrisi and A.Tu
Ricerca sci. (Italy), Vol. 30, No. 12, 2427-42 (Suppl. Dec., 19

Some data referred to the present solar cycle are prelim
examined, based on measurements made at the Astrophysica
servatory of Catania. These data are the Wolf relative numb
well as the areas of sunspots, faculae and prominences. The
of the minima and maxima, concerned with the four above me
features, are particularly considered. A comparison is mad
tween the sunspot areas as measured at Catania and those pu
in the Quarterly Bulletin, as well as between the classificati
sunspot groups made at Catania and that of the Fraunhofer In

18082 DETERMINATION OF ABUNDANCES IN THE SO
PHOTOSPHERE. GRAPHICAL AIDS IN GENERA
AND PARTICULARLY FOR THE CASE OF IRON.

E.Balli, N.Gökdoğan, M.Hotinli, R.Kandel, A.Kiral and J.C.Pe
Rev. Fac. Sci. Univ. Istanbul C (Turkey), Vol. 26, No. 1, 23-
(Jan., 1961). In French.

Graphical constructions, based on calculations using rec
solar models, are described and presented. Some have not
previously been published. They are designed to aid computa
of the various quantities involved in a detailed discussion of t
problems of local thermodynamic equilibrium in the solar atm
spheres, and specifically the derivation of atomic abundance v
from intensity measurements of selected Fraunhofer Fe lines
There are 31 graphs and charts. D.R.

18083 SUMMARY OF OUTSTANDING SOLAR EVENTS I
JULY 1959. A.H.Shapley and D.Trotter.

"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 79
of 1961) p. 72-6.

The outstanding features of solar activity are summarize
the associated geophysical effects tabulated. D.R.

18084 SOLAR CORPUSCULAR STREAMS AND GEOMAG
FIELD IN JULY 1959. V.I.Afanasieva and J.D.Ka

"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 79
of 1961) p. 76-8.

Conclusions are drawn regarding the nature of the geoma
and solar corpuscular phenomena observed in July 1959. The
geometry of the active solar regions is discussed in relation t
observed geomagnetic changes. D.R.

18085 THE JULY 1959 EVENTS AND ASSOCIATED PHENOMENA. INTRODUCTION. J.Bartels.

"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 79
1961) p. 3-5.

The month of July, 1959, was selected for special study b
Committee on Space Research (COSPAR) for the following rea
(1) the occurrence of 3 major solar flares, and geomagnetic s
between July 10 and 18, with associated cosmic ray phenomen
(2) the presence of polar cap absorption commencing ~ 80 mi
previous to the magnetic storm onset; and (3) the observation
additional low-energy cosmic radiation (coincident with the
geomagnetic activity) at heights > 30 km. D.R.

18086 PROBABILITY OF UNUSUAL ELEMENTS IN VE
BIG SOLAR FLARES CONNECTED WITH COSMIC
BURSTS. S.L.Malurkar.

Acta phys. Hungar., Vol. 12, No. 4, 359-60 (1960).

18087 THE RELATIONSHIP BETWEEN OPTICAL AND
RADIO-FREQUENCY EMISSIONS OF THE SOLAR
CORONA. M.N.Gnevyshev.

Astron. Zh. (USSR), Vol. 37, No. 2, 227-35 (March-April, 196
In Russian.

Complete and high-quality observations of the uneclipsed
corona were accumulated during the IGY. This made it possi
to carry out a more detailed correlation of coronal emission
λ 5303 A line, and at metre wavelengths with geomagnetic dis
ances than had been possible hitherto. The conclusions are a
follows: (1) The intensity of the coronal line λ 5303 A has a

num above sunspots, in the sense of distribution with respect h latitude and longitude. (2) The visible maximum in the ity of coronal features occurs one day after they cross the rn limb of the sun's disk, and a day after they cross the rn limb. (3) Radio-frequency emissions during noise storms, tre wavelength, show narrow directivity (solid angle not er than 10^0), with the intensity of the coronal line λ 5303 A ly increased at that point. (4) A noise storm is observed at wavelength, usually 2-4 days prior to a geomagnetic storm. sh translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 2, 4 (Sept.-Oct., 1960)].

38 THE POLARIZATION OF CORONAL EMISSION LINES.

ogilevskii, G.M.Nikol'skii and K.I.Nikol'skaya.
n. Zh. (USSR), Vol. 37, No. 2, 236-45 (March-April, 1960).
ssian.

wo spectrograms of the corona taken during the eclipse of 30, 1954 were studied. These were obtained with the ISP-65 atic spectrograph (λ 6374, 125 A mm^{-1}; λ 5303, 51 A mm^{-1}). llaston prism was placed behind the slit of the spectrograph, t spectrograms with mutually perpendicular polarization obtained simultaneously for the polar and equatorial regions eights ≤ 0.6 solar radius). The method of analysis of the rograms is described. The relative brightness of the F- and nponents of the corona was found from the blend Na λ 5893 A. = 1.3 solar radii it was found that $i_K/(i_K + i_F) = 0.8$, which good agreement with the model of the minimum corona r. 7640 of 1955). The variation of polarization in λ 5303 was mined for the equatorial zone of the corona, and in λ 6374 for lar zone. The polarization found for regions of the continuous rum adjacent to these lines is in agreement with data of other rs (e.g. Abstr. 37 of 1957). The variations of intensities of nes and the continuous spectrum were also determined. The legree of polarization in the lines permitted an estimate to be of the relative importance of photoexcitation and excitation by on impact for λ 5303 and λ 6374 at different heights. Experi- l values of the mean effective cross-section of line excitation ctron impact were derived: $\bar{\sigma}_{5303} = 0.77 \times 10^{-17}$ cm^2, $= 0.63 \times 10^{-17}$ cm^2. The value obtained for $\bar{\sigma}_{5303}$ is smaller than und by Wolley and Allen (1948). The results obtained are ssed. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, 225-33 (Sept.-Oct., 1960)].

089 THE GENERATION OF COSMIC RAYS IN FLARES.

A.B.Severnỹi and V.P.Shabanskii.
n. Zh. (USSR), Vol. 37, No. 5, 609-15 (July-Aug., 1960).
ssian.

pinch effect can be set up around the neutral point in a free tic field when the azimuthal fields of approaching force are annihilated by opposing longitudinal fields. The contrac- f plasma in the vicinity of the neutral point can also be produc- rapid changes in a sunspot field if this field is external and ipole character. In both cases, strong shock waves converging neutral point can appear. The incident shock front outruns oving region of strong magnetic field. As a result of reflection neutral plane, a high-temperature region is formed behind the ted shock front which moves to meet the contracting plasma. region is heated by the magnetic energy expended in creating mpressing the shock waves. Thermonuclear reactions occur region [up to 10^4 (D,D) reactions per cm^3 during the total lifetime]. The products of these reactions (protons) with ies of several MeV are accelerated up to energies of ~10 BeV lection from the strong magnetic field regions which are con- g on the neutral point. (Energy losses due to collision and ion are taken into account.) Such an energy gain is caused by tions; it depends only on the final displacement (from 10^8 to n) of the magnetic mirrors, and not on their velocity. sh translation in: Soviet Astron.-AJ (USA), Vol. 4, No. 4, (Jan.-Feb., 1961)].

090 THE NATURE OF γ-EMISSION IN SOLAR FLARES AND THE FORMATION OF COSMIC PARTICLES IN VE SOLAR REGIONS. I.M.Gordon.

n. Zh. (USSR), Vol. 37, No. 5, 934-7 (Sept.-Oct., 1960).
ssian.

everal arguments are advanced in support of the view that the ission observed during solar flares in an airborne balloon iment over Cuba was due to two-photon annihilation of positrons formed as a result of nuclear collisions between cosmic protons generated during chromospheric flares. Another possible source for the γ-emission is the reverse Compton effect. It is pointed out that, for the γ-emission to be of an annihilation nature, it must have a "step" in the region $E \sim 5 \times 10^5$ eV. Measurements of this type, employing balloons and artificial earth satellites, will make possible an unambiguous choice between these two hypotheses. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 5, 873-5 (March-April, 1961)].

18091 SPECTROPHOTOMETRY OF THE CHROMOSPHERIC LIMB FLARE OF OCTOBER 11, 1957. P.N.Polupan.

Astron. Zh. (USSR), Vol. 37, No. 6, 1032-42 (Nov.-Dec., 1960).
In Russian.

Profiles are obtained for the Balmer lines from H_α to H_9. Intensities are given in equivalent angstroms of the continuum at the centre of the solar disk; halfwidths are given in angstroms. It is shown that the Balmer-line broadening is due to macroscopic (turbulent) mass motions. The H_δ, H_ϵ, and H_9 profiles at maximum flare intensity can be represented by Doppler profiles without self-absorption, and H_α, H_β, and H_γ by Doppler profiles with self-absorption. Satisfactory agreement is obtained between the observed Balmer decrement (corrected for self-absorption) and the computed decrement at $T_e = 10\,000^0$ K and $N_H = 5 \times 10^{12}$, where n_H is the concentration of hydrogen atoms in the ground state. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 6, 965-75 (May-June, 1961)].

18092 GENERATION OF FLARES BY VARYING MAGNETIC FIELDS ON THE SUN. A.B.Severnyi.

Astron. Zh. (USSR), Vol. 38, No. 3, 402-8 (1961). In Russian.

Some new observations on the behaviour of magnetic fields during flares are described (Abstr. 14429 of 1960). The generation of a flare is considered to be due to the contraction of solar plasma, initially in equilibrium and concentrated near a neutral point, under the action of the increasing external magnetic field of sunspots. It is shown that even a comparatively slow increase in this field can lead to a rapid compression of the plasma, giving rise to shock waves converging to the neutral point and to the ejection of plasma from the region between the shock-wave fronts in a direction perpendicular to the compression. It is also shown that ohmic losses can play an important role in the slow heating of faculae. [English translation in: Soviet Astron.—AJ (USA), Vol. 5, No. 3, 299-303 (Nov.-Dec., 1961)].

18093 ACTIVE SOLAR REGIONS AND THEIR CORPUSCULAR EMISSION.

A.S.Dvoryashin, L.S.Levitskii and A.K.Pankratov.
Astron. Zh. (USSR), Vol. 38, No. 3, 419-38 (1961). In Russian.

A study is reported of the relation between absorption at high geomagnetic latitudes and disturbances in the earth's magnetic field, in connection with processes occurring in active solar regions. It is concluded from an analysis of experimental data that high-energy protons (~10-100 MeV) are produced on the sun. A consideration of the large delay in the arrival of the protons and the duration and isotropy of their precipitation into the polar cap, leads to the conclusion that approximately radial magnetic fields (with included irregularities) are present in interplanetary space. Their sources are the local magnetic fields of active regions and the general magnetic field of the sun, which are carried along by the ejected plasma. This conclusion is confirmed by the fact that a rapid arrival of protons from a flare is usually observed if the previous flare in the given region gave rise to a magnetic storm. This means that the protons are injected into an approximately radial magnetic field due to the local magnetic field of the active region, and carried along by the previously ejected plasma. The several prolonged polar cap absorptions during 1957-1959 are explained by the injection into this field of high-energy protons associated with the development of flares, the protons being produced within the given active region during its passage across the solar disc. Since the magnetic field remains associated with the sun, the rotation of the sun tends to bend the magnetic lines of force even at the distance of 1 A.U. This is confirmed by the difference in the arrival delay time of high-energy protons injected from active regions located on the west and east hemispheres of the sun. It is established that magnetic storms with sudden commencement, which are due to the injection of solar plasma during the development of chromospheric flares and are accompanied by the generation of high-energy protons, have as a rule a shorter delay time, a larger sudden commencement amplitude, and are accompanied by a larger Forbush decrease in the intensity of galactic cosmic radiation. A relation is found between the intensity of magnetic storms and the coordinates of flares. Using the flare-storm identification, it is shown that a disturbance from the sun is propagated very nearly through a complete hemisphere, the main mass of the "stream" being concentrated in a 60° cone. [English translation in: Soviet Astron.—AJ (USA), Vol. 5, No. 3, 311-25 (Nov.-Dec., 1961)].

18094 OBSERVATION OF A SOLAR BREMSSTRAHLUNG BURST OF 1926 U.T., AUGUST 11, 1960.

J.R.Winckler, T.C.May and A.J.Masley.

J. geophys. Res. (USA), Vol. 66, No. 1, 316-20 (Jan., 1961).

A burst of bremsstrahlung, originating on the sun during a class 2+ flare, was observed by means of balloon detectors. The total bremsstrahlung energy leaving the flare is estimated as at least 5 × 10^{35} eV. The X-ray burst, which was produced during the initial rise in intensity of the flare, appears to be correlated with Type III radio emission but not with Type II. This result supports C.de Jager's hypothesis that flare X-rays are generated by electrons accelerated near shock fronts in the collapsing magnetic field of a sunspot group. G.R.Greatrix

18095 PHOTOMETRIC INVESTIGATION OF THE INNER SOLAR CORONA USING AN ECLIPSE PLATE OF 1927 JUNE 29.

H.von Klüber.

Monthly Not. Roy. Astron. Soc. (GB), Vol. 123, No. 1, 61-80 (1961).

A number of isophotes of the innermost corona in integrated light was determined on a very large plate obtained in 1927 by an eclipse expedition of the Hamburg Observatory, using a camera of 20 m focal length and 1 sec exposure time. The corresponding photometric intensities and electron densities could be derived using calibrated photographs of the same corona from other sources. Intensities and their gradients and amplitudes around the limb of the sun were determined and graphically represented within the range of 0'.7 to 3'.7 distance from the sun's limb. Conclusions as to the formation of zones in the innermost corona were drawn. Finally some measures of an interesting "dome-formation" of this corona are given.

18096 OBSERVATION OF SOLAR PROMINENCES, 1959, AT ARCETRI OBSERVATORY.

G.Noci and M.Rigutti.

Mem. Soc. Astron. Ital., Vol. 32, No. 1, 85-96 (1961). In Italian.

The results of the observations of prominences carried out in 1959, in accordance with the programme of work at the Arcetri Observatory, are given.

18097 NEW REDUCTION OF THE OBSERVATIONS OF PROMINENCES MADE AT THE ASTROPHYSICAL OBSERVATORY OF ARCETRI DURING THE CYCLES 17, 18, 19.

G.Godoli.

Mem. Acad. Naz. Lincei (Italy), Vol. 6, No. 6, 89-181 (1961). In Italian.

A detailed report of observations of solar prominences for the eleven year cycles 1933-44-53, and for part, 1954-58, of the present cycle. R.A.Newing

18098 COINCIDENCE OF THE EXPLOSIVE PHASE OF SOLAR FLARES WITH 10.7 cm SOLAR NOISE BURSTS.

A.E.Covington and G.A.Harvey.

Nature (GB), Vol. 192, 152-3 (Oct. 14, 1961).

From a study of nine selected flares conclusions are drawn regarding the correlation of different features of the optical event with radio events of both impulsive and long-enduring types. P.A.T.Wild

18099 OBSERVATION OF A WHITE-LIGHT FLARE.

K.Angle.

Publ. Astron. Soc. Pacific (USA), Vol. 73, 227-9 (June, 1961).

18100 AUTOCORRELATION METHOD AND CYCLES OF SOLAR ACTIVITY.

A.Kiral.

Rev. Fac. Sci. Univ. Istanbul C (Turkey), Vol. 26, No. 1, 12-22 (Jan., 1961). In French.

Using the data of Schove [J. geophys. Res. (USA), Vol. 60, 127 (1955)] the existence of a long solar cycle of 80 years (7 cycles of eleven years) was confirmed with the aid of the autocorrelation method and the power spectrum established by Gleissberg using his method of secular smoothing. This existence was also proved periods of solar activity of 2, 9, and 18 cycles of eleven years, the possibility considered of rejecting all other cycles. In the cation of this method the numbers of cycles of eleven years wer taken as independent variable instead of time.

18101 THE HEATING OF THE CHROMOSPHERE THROUG THE DISSIPATION ENERGY OF TURBULENT FLO

A.Unsöld.

Z. Astrophys. (Germany), Vol. 52, No. 4, 300-2 (1961). In Germ

Estimates of the orders of magnitude of turbulent energy dissipation and radiation energy emission and also of the chara istic times for these two processes are used in an examination physical conditions necessary for the applicability of the theory. R.A.Ne

THE INFLUENCE OF SMALL FLARES ON THE INTENSIT OF THE NEUTRON COMPONENT OF COSMIC RAYS.

See Abstr. 16943

18102 DETERMINATION OF DIFFERENTIAL LIMB DARKENING OF ECLIPSING BINARIES FROM MUL- COLOR PHOTOMETRIC OBSERVATIONS. I.

K.Serkowski.

Astron. J. (USA), Vol. 66, No. 8, 405-12 (Oct., 1961).

The linear equations are presented which describe the obse colour indices of an eclipsing binary during the eclipse as functi of the difference of limb darkening coefficients, difference of intrinisic colours, and corrections to the rectification constants. The ratio of radii of the components of the eclipsing binary, the ratio of their luminosities in one colour, and the coefficients of limb darkening in this colour are the only elements of the syste upon which the coefficients of these equations depend. A least-squares solution of the equations describing the colour indices YZ Cassiopeiae observed by Kron gives for the star eclipsed in primary minimum a difference of limb darkening coefficients $u^{4500} - u^{6700} = 0.35 \pm 0.02$ (m.e.) which is about twice as large as value 0.16 ± 0.08 resulting from independent solutions in each colour.

18103 THE ECLIPSING SYSTEM V TUCANAE.

F.B.Wood and G.E.McCluskey, Jr.

Astron. J. (USA), Vol. 66, No. 8, 413-17 (Oct., 1961).

Photoelectric observations of 171 yellow and 169 blue magnitudes of V Tucanae are presented. The available evidence indicates a constant period. The system was brighter on two nights than on the others. The preliminary elements and their permissible ranges are computed.

18104 A SEARCH FOR STARS OF LOW LUMINOSITY.

G.Van Biesbroeck.

Astron. J. (USA), Vol. 66, No. 9, 528-30 (Nov., 1961).

Photographic searches with the 82 in. reflector in the neighbo hood of about 650 stars of large proper motion revealed that 12 of them have faint companions, and since their parallaxes are generally also large these companions must be of intrinsically lo luminosity. Seventeen new and generally faint stars of large proper motion were also discovered on the plates. Finding chart are provided.

18105 TURBULENCE AND ROTATION IN EARLY-TYPE STARS.

A.J.Meadows.

Monthly Not. Roy. Astron. Soc. (GB), Vol. 123, No. 1, 81-6 (1961).

The spectra of 54 early-type stars in galactic clusters were examined in an attempt to discover the regions in the H—R diagra where large-scale turbulence and rotation are, respectively, the major sources of spectral line broadening. A demarcation line be tween the two regions, which varies with spectral type and absolu magnitude, was found. The factors determining the position of thi line are discussed, and the results are compared with previous stellar rotational velocity measurements.

18106 THE THEORY OF STELLAR EVOLUTION.

V.V.Sobolev.

Astron. Zh. (USSR), Vol. 37, No. 3, 387-95 (May-June, 1960). In Russian.

The problem of non-steady transfer of radiation in a star is considered. The mean time of escape of energy from a star is estimated. Certain conclusions are drawn about the equations

ribing stellar evolution. [English translation in: Soviet
ron.—AJ (USA), Vol. 4, No. 3, 372-9 (Nov.-Dec., 1960)].

18107 STELLAR EVOLUTION WITH MASS LOSS.

E.Schatzman.

n. Soc. Roy. Sci. Liege (Belgium) Sér. cinquième, Vol. III, 295
0).

A brief note, substantially as follows. It is proved that, at the
nd order approximation, a free wave does not transport mass,
on-zero terms cancelling each other. Except for eruptions
ch are not considered) the only possibility of mass loss is the
which has been considered by Parker (1959): mass loss by the
na of the star. The mass loss is proportional to the mechanical
rgy transported into the corona by compression waves and hydro-
netic waves. Ultimately, the mechanical energy is due to the
ions in the convective zone. Therefore, the rate of mass loss in
ts with a thick convective zone is larger than in dwarfs with a
convective zone; moreover, the velocity of escape in giants is
ller than in dwarfs. Consequently, stars do lose mass during
passage through the giant branch.

18108 VIBRATIONAL STABILITY OF STARS OF ORIGINALLY PURE HYDROGEN.

P.Ledoux and A.Boury.

n. Soc. Roy. Sci. Liege (Belgium), Sér. cinquième, Vol. III,
-314 (1960). In French.

The stability is discussed, in a first approximation, with the
of the standard model. The upper limit M_c to the stable
sses depends on the amount of helium accumulated in the central
ion during the contracting stages preceding a true equilibrium
e in which the luminosity is balanced by the energy liberated by
reactions of the p—p chain. According as to whether the helium
ndance is smaller or larger than about 10^{-4}, M_c is of the order
00 or 1200 solar masses. This is much larger than what can be
ected once the central hydrogen has been largely consumed and
(3α) reaction starts to be the dominating source of energy.
s, at this stage of evolution, it may be expected that an appreci-
number of primitively stable stars would become unstable,
dding their material still mainly composed of hydrogen in the
rounding space.

18109 ON THE EVOLUTION OF MASSIVE STARS.

J.Uchida.

Rep. Tohoku Univ. First Ser. (Japan), Vol. 43, No. 3, 171-80
t., 1959).

Eight successive models of a star of ten solar masses are
puted to find an accurate evolutionary sequence. Each model,
ept the starting homogeneous one, consists of three regions: a
ogeneous radiative envelope, an intermediate radiative zone
continuously varying composition and a homogeneous convective
e. An interpolation formula for the opacity adjusted to the
ler—Meyerott tables (Abstr. 7804 of 1955) is derived and used
the radiative region. Radiation pressure is taken wholly into
ount. Neglecting yhe energy generation outside the core, the
rogen content in the core is found to change from 83 to 0.3%.
paring the evolutionary sequence with those obtained by previous
k, it is found that there is no essential difference between them.

18110 EVOLUTIONARY MODEL SEQUENCE OF A STAR OF TEN SOLAR MASSES.

Y.Iinuma.

Rep. Tohoku Univ. First Ser. (Japan), Vol. 43, No. 4, 232-44
c., 1959).

Starting from Kushwaha's model 3 (Abstr. 4682 of 1958) a
uence of evolutionary tracks of 10 stars is constructed, which
sists of models with convective cores, with isothermal cores,
with gravitationally contracting cores. Each model has an
rmediate zone in which hydrogen content is determined by the
of C—N cycle of the preceding model.

8111 MEAN DENSITIES OF VISUAL BINARY STARS.

M.A.Giannuzzi and L.Bianco.

ron. J. (USA), Vol. 66, No. 8, 418-23 (Oct., 1961).

Mean densities of 52 visual binaries and 82 eclipsing variables
e calculated without employing parallax values by using a
thod originally proposed by Öpik. The visual double stars seem
he average to be 10 times denser than photometric binaries,
their mean density is normally similar to the sun's density.
y likely, however, the difference between densities in the two
es of binary systems is the result of observational selection.

18112 THE RATIO OF TOTAL TO SELECTIVE ABSORPTION.

V.M.Blanco and C.J.Lennon.

Astron. J. (USA), Vol. 66, No. 9, 524-5 (Nov., 1961).

The ratio R of visual absorption to B—V colour excess is computed for stars of various spectral types as a function of the total colour excess. The results are summarized in a diagram.

18113 ABSORPTION LINE PROFILES IN SPECTRA OF NOVAE.

E.P.Krasnozhenov and V.V.Porfir'ev.

Astron. Zh. (USSR), Vol. 37, No. 3, 589-90 (May-June, 1960). In Russian.

The profile of an absorption line formed in an expanding envelope with a velocity gradient is constructed. The profile of the absorption coefficient is assumed to be of Doppler form. [English translation in: Soviet Astron—AJ (USA), Vol. 4, No. 3, 560-1 (Nov.-Dec., 1960)].

18114 THE INFLUENCE OF CARBON ON IONIZATION IN STELLAR ATMOSPHERES.

F.Praderie.

C.R. Acad. Sci. (France), Vol. 252, No. 26, 4114-16 (June 26, 1961). In French.

A consideration of the (θ, log p_e) diagram (where $\theta = 5040/T$) shows that a change in the abundance of carbon from 10^{-4} to 10^{-2} can cause the ratio p/p_e to alter by a factor of more than 30, and indicates that the ratio is most sensitive to the carbon abundance for F stars. G.A.Chisnall

BETA DECAY OF NUCLEI IN STELLAR INTERIORS. See Abstr. 17016

PROPAGATION OF SPHERICAL SHOCK WAVES IN STELLAR INTERIORS. See Abstr. 18455

18115 THE INFLUENCE OF TERMS WITH HIGH QUANTUM NUMBERS ON THE CALCULATION OF PARTITION FUNCTIONS AND OF THE POPULATION OF [ATOMIC] LEVELS.

C. van't Veer-Menneret.

C.R. Acad. Sci. (France), Vol. 253, No. 3, 380-2 (July 17, 1961). In French.

Although the partition functions may be affected by a factor of about 2, the terms of high quantum number contribute little to the determination of the population of atomic levels. This seems to be true for a wide range of stellar types. The contribution is only of order 10^{-2} for the extreme case of the white dwarfs. D.A.Chisnall

18116 NUCLEAR REACTIONS IMPORTANT IN ASTROPHYSICS.

E.Schatzman.

J. Phys. Radium (France), Vol. 21, No. 5, 361-4 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The nuclear reactions important for an understanding of the energy production rate and chemical composition of stars are considered. In the centre of gravity system: (a) the reactions in main sequence stars mainly occur around a few keV; (b) alpha-particle reactions in giant stars take place mainly around 80 keV; (c) the carbon reactions, $C^{12}(C^{12},p)Na^{23}$ and $C^{12}(C^{12},\alpha)Ne^{20}$, can be important at somewhat higher temperatures, principally in the region of 1.5 MeV. All these reactions are either important in energy production or in the development of stellar chemical composition. Certain peculiarities in the latter give rise to the consideration of surface nuclear reactions in the 6—20 MeV range, which lead through reactions of the type (p,n), (p,pn), (p,2n) to neutron formation and by neutron capture (n,p), (n,γ), (n,2n) to the production of heavy elements. Many of the cross-sections are only estimates or extrapolated from much higher energies. Attention is drawn to the astrophysical importance of the measurement of these cross-sections.

18117 ON THE POSSIBILITY OF REJUVENATION OF STARS BY ACCRETION.

H.Lambrecht.

Mem. Soc. Roy. Sci. Liege (Belgium), Sér. cinquième, Vol. III, 318-19 (1960).

The possibility is considered of main-sequence stars of mid-, or late-spectral types changing into massive stars of high luminosity by accretion of interstellar material. Values of the ratio, N_{acc}/N_{obs}, of the computed number of O-B stars to the numbers actually observed as a function of cloud density are derived, and tabulated. Results indicate that only with extremely great cloud densities can any appreciable fraction of the highly luminous main-sequence stars be formed by capture of interstellar material. Thus, accretion cannot play an essential role in stellar evolution.

D.R.Barber

18118 THE INFLUENCE OF THE METAL ABUNDANCE ON THE CONTINUOUS STELLAR SPECTRA.

C.de Jager and L.Neven.
Mem. Soc. Roy. Sci. Liege (Belgium), Sér. cinquième, Vol. III, 413-26 (1960).

A discussion of the difficult problem of typing the spectra of stars with low metal abundances, e.g. the extreme population II stars. The various parameters used by different observers for classification purposes are reviewed. Some stellar photospheric models are examined in which the only atoms involved are H and He. Their radiation fluxes at selected wavelengths between 3000 and 5000 A are compared directly with the results for similar models having a mixture containing metals. The conclusions will assist in the interpretation of spectra of stars having intermediate metal abundances.

D.R.Barber

18119 EVOLUTION OF A STAR WITH INTERMEDIATE MASS AFTER HYDROGEN BURNING.

C.Hayashi, M.Nishida and D.Sugimoto.
Progr. theor. Phys. (Japan), Vol. 25, No. 6, 1053-6 (June, 1961).

A report of calculations made in a study of the evolution of a star of 4 solar masses in the helium burning stage. The evolutionary track in the H–R diagram is compared with the stars of the blue globular cluster NGC 458.

R.A.Newing

18120 ON THE CORONAL LINES AND POSSIBLE RADIO EMISSION FROM REPEATING NOVAE. G.Wallerstein.

Publ. Astron. Soc. Pacific (USA), Vol. 73, 153-8 (April, 1961).

Describes calculations which show that the shock wave due to the expanding shell could heat a circumstellar envelope, with 10^7 particles per cm^3 before the outburst, sufficiently to produce the observed coronal lines, and possibly also detectable microwave radiation.

J.Hawgood

18121 ON THE EXISTENCE OF A NEW POLARIZATION-EFFECT IN STELLAR SPECTRAL-LINES.

T.Tamburini and G.Thiessen.
RC Accad. Naz. Lincei (Italy), Vol. 30, No. 4, 492-6 (April, 1961).

An examination is made of the possibility that the equivalent widths of the spectral lines of stars having a partially polarized continuum could be dependent on the plane of vibration of the respective light components being studied. For each of the seven stars examined two spectra were exposed on the same plate, one for the direction parallel ($||$), the other for the direction perpendicular ($\perp$) to the plane of maximum vibration. For both spectra the equivalent widths $W_\perp$ and $W_{||}$ of the Balmer lines H_β, H_γ, $H_{\delta,\epsilon}$ and $H_{8,9}$ were measured, and the ratio $W_\perp / W_{||}$ determined. The mean value of $W_\perp / W_{||}$, for all the lines and all the stars considered, is 1.05 ± 0.02. It is shown that no systematic or instrumental error could have been responsible for the observed effect and it therefore seems quite probable that $W_\perp / W_{||} > 1$.

G.R.Greatrix

18122 RAPID THERMONUCLEAR REACTIONS IN SUPERNOVA EXPLOSION. S.Hayakawa, C.Hayashi and M.Nishida.

Suppl. Progr. theor. Phys. (Japan), No. 16, 169-97 (1960).

In relation to the relative abundances of heavy nuclei in primary cosmic rays (Abstr. 13548 of 1961), the rapid thermonuclear reactions that may occur in the supernova envelope are investigated. The reaction rates of important processes, mostly resonance reactions at about 10^9 °K, are tabulated. These rates are used to discuss reactions which have lifetimes shorter than about 10^2 sec. Neutron production through $Ne^{21}(\alpha, n)Mg^{24}$ and $Mg^{25}(\alpha, n)Si^{28}$ reactions is examined and is found to be possible, if Ne^{21} and Mg^{25} are formed in the hydrogen burning zone by the Ne–Na and the Mg–Al cycles at temperatures slightly below 10^9 °K and densities around 1 g cm^{-3}, and then α-particles thus formed by the cycles induce (α, n) reactions. The neutrons thus produced can trigger the rapid CNO cycle. As the temperature decreases with time, neutrons are lost so that the cycle goes through β^+-decays in place of (n, p) reactions. Then the abundances of β^+-unstable nuclei increase, but many of them are eventually converted into carbon through the last frozen reaction $N^{15}(p, \alpha)C^{12}$. All nuclei heavier than neon are p- duced by rapid α-capturing reactions with the supply of α-partil by the photo-dissociation of Ne^{20} as well as by the pre-existing n The rapid proton capture reactions are shown to account for th peak. The above results account for the characteristic features of the relative abundances of cosmic-ray nuclei, especially the ov- abundances of C and Mg and the under-abundance of Ne, relati the average galactic abundances. The rapid reactions are rega as taking place in the burning front associated with the shock w produced by the supernova explosion.

18123 NEUTRAL HYDROGEN IN EXTRAGALACTIC SYST L.Volders and H.C.van de Hulst.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 423-30.

Measurements were made of the 21 cm emission from the external galaxies M31, M33, M101, IC1613, NGC 6822 and M81. M33 has a hydrogen mass of 0.92×10^9 solar masses and a tota mass of 18×10^9 solar masses. The plane of M101 is inclined $30^0 \pm 9^0$ to the line of sight and has a hydrogen mass of 3×10^9 solar masses.

R.D.D

18124 HYDROGEN-LINE OBSERVATIONS ON THE COMA CLUSTER. C.A.Muller.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 465.

An attempt was made to confirm the measurement by Heesc of neutral hydrogen in the Coma cluster. No hydrogen was detec and the upper limit of the aerial temperature of the emission wa

R.D.Dav

18125 ON THE UPPER LIMIT OF THE GALACTIC MAGNE FIELD. A.G.Pacholczyk.

Ann. Astrophys. (France), Vol. 24, No. 4, 309-10 (1961).

The stabilizing effect of the galactic magnetic field on the process of formation of the spiral arms by the gravitational inst ility of the primary galaxy is considered in order to determine t upper limit of the magnetic flux density in such a primary galaxy The limiting value of this magnetic field is estimated as 4×10^{-6} gauss.

18126 A SYSTEMATIC EFFECT IN THE REDSHIFTS OF EXTRAGALACTIC NEBULAE. E.Holmberg.

Ark. Astron. (Sweden), Vol. 2, Paper 51, 559-82 (1961).

An analysis of the Humason–Mayall redshift catalogue leads the conclusion that the redshift measurements suffer from a systematic effect that is related to the amount of light reaching t spectrograph plate (or to the average plate density of the spectra region measured). The effect, which is interpreted as observati errors of a systematic nature, offers a natural explanation of the excessive redshift dispersion found for clusters and groups of nebulae.

18127 THE DISTRIBUTION OF STARS IN THE SCULPTOR DWARF GALAXY. P.W.Hodge.

Astron. J. (USA), Vol. 66, No. 8, 384-90 (Oct., 1961).

Star counts on six Schmidt plates, covering the Sculptor dwa galaxy and the surrounding area, provide information on the dis bution of the brightest stars in the system. Equidensity contours drawn from the counts are smooth ellipses with ellipticity 0.35. Density profiles along the major axis do not agree with Hubble's or de Vaucouleurs' interpolation formulae for luminosity profiles of giant ellipticals. The size of the Sculptor system as observed agrees well with the computed tidally limited size caused by the attraction of our Galaxy on its outer stars.

18128 MULTICOLOR PHOTOELECTRIC PHOTOMETRY O BRIGHT GALAXIES. I. W.G.Tifft.

Astron. J. (USA), Vol. 66, No. 8, 390-404 (Oct., 1961).

Photoelectric observations are presented for 57 galaxies an 52 stars as obtained with a blue-sensitive photocell. The respon bands have effective reciprocal wavelengths of 2.66, 2.39, 2.07, and 1.68 (micron units). In addition, 8 galaxies and 19 stars wer observed in the red and infrared. The effective reciprocal wavelengths for the red response bands are 1.55, 1.26, 1.14, and 1.00. From one to five aperture sizes were used in the photometry of each galaxy, with an average of three per galaxy. All the observ tions were reduced to an absolute energy colour system by mean lirect comparisons between the response of the photocell and er combinations and the response of a thermocouple. A sub- quent paper will contain the bulk of the discussion of the data.

18129 THE COMPARISON OF GALAXY DIAMETERS.

B.A.Vorontsov-Vel'yaminov.

tron. Zh. (USSR), Vol. 37, No. 4, 778-80 (July-Aug., 1960). Russian.

Different methods for the determination of the diameters of iral galaxies give results which are precipally not comparable. is proposed that diameters of distinctly visible spiral patterns compared. Their diameters depend only very slightly on posures, etc. The definition of diameters of elliptical galaxies be used for comparison is less obvious. At the present stage, comparison of diameters of spiral and elliptical galaxies has sense until the physical and practical determination of the undaries of galaxies has been properly adjusted. [English trans- ion in: Soviet Astron.—AJ (USA), Vol. 4, No. 4, 735-7 n.-Feb., 1961)].

18130 GALACTIC STRUCTURE AT OPTICAL AND RADIO WAVE-LENGTHS. M.Schmidt.

Roy. Astron. Soc. Canada, Vol. 55, No. 4, 149-66 (Aug., 1961).

A review of present knowledge concerning the distribution of jects, including globular clusters and interstellar clouds, within r own Galaxy, determined from observations at optical and radio equencies. A comparison between neutral H structure and the stribution of emission regions shows that discrepancies occur in e direction of Perseus-Cassiopeia, and possibly also in the rection of Cygnus. A brief discussion of the dynamics and olution of the Galactic system ensues. D.R.Barber

18131 THE ROTATION OF BARRED GALAXIES UNDER GRAVITATIONAL FORCES. II. S.Aarseth.

onthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 6, 535-41 (1961).

For Pt I, see Abstr. 12774 of 1961. Several models of barred iral galaxies in rotation under purely gravitational forces are mputed. A homology relation is found thereby extending the range the results available for rotating systems. Approximate formulae e given for the period of rotation and the bar mass in terms of e inner and outer radius and the central mass. The problem is odified by taking the nucleus to be an oblate spheriod and it is und that the stability of the bar remains approximately the same r eccentricities < 0.5. It is predicted that the inner bar will velop trailing arms. The mass of the barred system NGC 7479 is timated to lie in the region 2.4-2.9×10^{10} $\odot$.

18132 THE 1960 PALOMAR SUPERNOVA SEARCH.

M.L.Humason, A.M.Gomes and C.E.Kearns.

bl. Astron. Soc. Pacific (USA), Vol. 73, 175-81 (June, 1961).

During 1960, nineteen supernovae were found with the 48 in. hmidt telescope at Palomar and all were confirmed on two or ore plates.

18133 STELLAR CONTENT OF GALAXIES.

H.Arp.

ience (USA), Vol. 134, 810-19 (Sept. 22, 1961).

Review article.

OPTICAL OBSERVATIONS OF NONTHERMAL GALACTIC DIO SOURCES. See Abstr. 18178

adioastronomy

18134 THE PROBLEM OF CONFUSION IN SURVEYS OF SOURCES. M.Ryle.

dio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 60) p. 475-6.

The uncertainties introduced by confusion into radio astronomi- l observations depend upon the problem being studied. For the curate determination of source positions, only one source per 0 beamwidths can be observed. If flux densities are required to accuracy of 25%, one source can be taken for 10 beamwidths, d if the general distribution of sources in space is needed one urce per beamwidth is allowable. R.D.Davies

18135 STUDIES OF RADIO SOURCES AT 159 Mc/s.

S.Archer, J.E.Baldwin, D.O.Edge, B.Elsmore, P.A.G.Scheuer and J.R.Shakeshaft.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 487-91.

A four-aerial interferometer was used at 159 Mc/s to compile a new list of radio sources to be known as 3C. The agreement between this list and either 2C or the survey of Mills and Slee is not complete. The slope of the graph of log N against log S is -2.2 for one limited region. A statistical study of the deflection of all the interferometer records shows also a deficiency of bright sources. R.D.Davies

18136 PRELIMINARY RESULTS OF THE OBSERVATION OF RADIO SOURCES WITH THE NANÇAY INTERFEROMETER. A.Boischot.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 492-5. In French.

The Nançay interferometer operating at 169 Mc/s has a lobewidth of 3'.8. A catalogue is presented giving the position and intensity of 25 sources and comparing these observations with the 2C results. R.D.Davies

18137 STUDIES IN COSMIC RADIO NOISE AT BANGALORE (SOME SPECIAL FEATURES).

S.Bhagavantam, M.Krishnamurthi and S.Ramakrishna.

J. Indian Inst. Sci., Vol. 43, No. 2, 97-103 (April, 1961).

A brief description of the different techniques now being employed an Bangalore for conducting a radio survey of the sky at 28.6 Mc/s and 62 Mc/s and for making observations on the disturbed sun at these frequencies is given. Some special features noticed during the work and relating to the ionosphere, the brightness temperatures at the frequencies employed and solar radio emission are indicated in the paper.

18138 INTERPRETATION OF COSMIC NOISE MEASUREMENTS AT 3.8 Mc/s FROM SATELLITE 1960 η 1.

J.H.Chapman and A.R.Molozzi.

Nature (GB), Vol. 191, 480 (July 29, 1961).

Analysis of the variation in field-strength of 3.8 Mc/s cosmic noise from the satellite at different locations shows that the most important factors affecting the signals are (i) variation of radiation resistance of the antenna due to the ionosphere, (ii) restriction in angular aperture of the antenna due to the ionosphere, and (iii) variation of cosmic noise power over the sky. G.M.Brown

18139 A COMPARISON OF AN INTERFEROMETER AND TOTAL POWER SURVEY OF DISCRETE SOURCES OF RADIOFREQUENCY RADIATION. C.Hazard and D.Walsh.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 477-86.

A survey of a part of the sky was performed at 92 Mc/s with both an interferometer and a total power set. Out of 81 sources on the total power list and 102 on the interferometer list only 40 agreed in position. This discrepancy is attributed to the fact that too many sources per beamwidth were catalogued. It is concluded that one source per 25 beam areas should remove the effects of confusion. R.D.Davies

18140 INCREASE OF THE SENSITIVITY AND DIRECTIVITY OF RADIO INTERFEROMETERS.

V.A.Sanamian and H.M.Tovmasian.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 496-7.

Two techniques are described for increasing the effective time constant of an interferometer. One uses photographic integration and the other uses a resonant system with a natural frequency equal to that of the interference pattern. High resolution in declination is possible with the latter system. R.D.Davies

18141 THE NORTH—SOUTH MULTIPLE-LOBE ARRAY OF THE LARGE INTERFEROMETER AT NANÇAY.

E.J.Blum.

Ann. Astrophys. (France), Vol. 24, No. 4, 359-66 (1961). In French.

The N—S line of 8 aerials, 770 metres long completes the Nancay 32-aerial E—W interferometer on 167 Mc/s, A receiver with several detectors permits simultaneous observation in 15 directions in space, and is used for solar measurements. To determine the position of a radio-source, the two arrays are coupled so as to produce the product of their respective voltages, and use the multi-channel system. The particular devices employed in this instrument are described, and the precision obtained is indicated.

18142 EFFECTS OF ANTENNA SCAN RATE AND RADIOMETER TIME CONSTANT ON RECEIVER OUTPUT.

W.E.Howard, III.

Astron. J. (USA), Vol. 66, No. 9, 521-3 (Nov., 1961).

An expression is developed from which one may predict. (1) the amplitude, (2) the time delay in reaching the peak, and (3) the response width of the receiver output, given a receiver input that is a Gaussian function of time. The expression depends on the receiver time constant and the response width of the input Gaussian which, in turn, depends on the aerial beamwidth B, the width of the source at half intensity S, and the scan rate α.

18143 ON THE THEORETICAL LIMITATION OF A RADIO TELESCOPE IN DETERMINING THE SKY TEMPERATURE DISTRIBUTION.

Y.T.Lo.

J. appl. Phys. (USA), Vol. 32, No. 10, 2052-4 (Oct., 1961).

The problem of aerial smoothing is re-examined. By taking into account noise contributions it is concluded that a practical limit to mapping sky temperature distribution does exist.

G.L Verschuur

18144 CIRCULAR AERIAL ARRAYS FOR RADIO ASTRONOMY.

J.P.Wild.

Proc. Roy. Soc. A (GB), Vol. 262, 84-99 (June 13, 1961).

A new type of aerial array suitable for high-resolution observations in radioastronomy is explored theoretically. The array consists of a large number of aerial elements equally spaced round a circle and electrically connected in phase. The power polar diagram is calculated for the cases when the circle is effectively continuous, and when the separation between adjacent elements is appreciable. In both cases the side-lobe level is rather high for most radioastronomical purposes, for which a process of aerial correction is required. The function of the correction process is to readjust the relative weights of the different spatial Fourier components to provide a suitable beam shape. A general method of aerial correction is developed in which the two-dimensional distribution of brightness directly recorded by scanning is cross-correlated with a circularly symmetrical correction function, a process which is desirably performed in the instrument itself. The correction process allows one to convert the polar diagram of a ring-shaped array into (for example) the diagram of a uniform circular aperture of the same radius. The principal theoretical characteristics of the circular array are briefly compared with those of the Mills cross. It is found that while the process of aerial correction or "tapering" is technically more straightforward in the cross, the circular array has the following advantages: (1) the length of transmission line (and hence attenuation) between each element and receiver is halved; (2) the number of elements required to gain the same information is reduced, approximately in the ratio 4 : π; (3) the beam possesses circular or elliptical symmetry; and (4) the system offers the possibility of direct phase and amplitude calibration with the aid of a transmitter situated on a central tower.

18145 THE EDGE FOCUSING OF A RADIO SIGNAL RECEIVED FROM OUTSIDE THE EARTH BY AN AERIAL WITHIN THE IONOSPHERE.

K.G.Budden.

Proc. Roy. Soc. A (GB), Vol. 263, 552-66 (Oct. 10, 1961).

For an aerial within the ionosphere, there is a cone of directions within which a radio signal coming in to the earth can reach the aerial. The variation of signal with angle near the edge of this cone is given by an Airy integral function or its derivative, and methods of finding this function are given for an isotropic horizontally stratified ionosphere, both when the earth is assumed to be flat and when its curvature is allowed for. For directions well within the cone, two different rays can reach the receiver, and one of them touches a caustic surface and in consequence suffers a phase change of 90°. For an anisotropic ionosphere, the form of the results would be similar, but further study of the electromagnetic equations within the ionosphere is needed before they can be given in detail.

18146 SUMMARY OF SPECTRAL OBSERVATIONS OF SOLAR RADIO EMISSION DURING JULY 1959.

M.P.Hughes.

"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 79-80.

A diagram is included illustrating the time-relationship between solar radio-bursts, planetary magnetic indices, neutron counts a sea-level, and associated polar ionospheric absorption.

D.R.Ba

18147 BURSTS OF RADIO-EMISSION OF THE SUN OF TYPE IV AND DISTURBANCE OF THE MAGNETIC FIELD OF THE EARTH IN JULY 1959.

E.I.Mogilevsky, S.T.Akinyan and J.N.Koulikova.

"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 81-3.

Main features of the exceptional outbursts occurring in each the July events listed are tabulated.

D.R.Ba

18148 REMARKABLE RADIO-FREQUENCY EMISSIONS IN JULY 1959.

J.F.Denisse.

"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 1961) p. 153. In French.

Tabulations are given of duration and maximum flux density 2800, 545, and 169 Mc/s for the type-IV radio storms of 9, 10, 1 and 16 July. The four events appeared to have been associated w the same centre of solar activity.

D.R.Bar

18149 GENERAL SURVEY ON SOLAR PHENOMENA.

M.Minnaert.

"Solar radioastronomy", Varenna Summer School, 1959 (see Ab 15532 of 1961) p. 1-38.

18150 RADIO EMISSION OF SOLAR ORIGIN.

R.Coutrez.

"Solar radioastronomy", Varenna Summer School, 1959 (see Abst 15532 of 1961) p. 117-216. In French.

A review article, starting from first principles. Part I deals with instrumental techniques; Part II describes the emissions fro the quiet and disturbed sun, and theories of their origin.

H.Rishbe

18151 DETECTION AND OBSERVATION OF SOLAR EMISSION IN THE RANGE OF CENTIMETRE-WAVES

O.Hachenberg.

"Solar radioastronomy", Varenna Summer School, 1959 (see Abst 15532 of 1961) p. 217-80

A review of basic observational techniques is given, and thei application to the study of the different types of radio emission discussed. Observed characteristics of burst radiation in the centimetre range are summarized; their possible correlation wit metre-range, optical, X-ray and corpuscular emission is conside Conclusions are drawn with regard to the regions of the solar atmosphere in which these types of radiation are generated. An attempt is made to classify flares into four groups, characterized by the types of radiation associated with them.

P.A.T.W

18152 SOLAR RADIO INTERFEROMETRY.

J.P.Wild.

"Solar radioastronomy", Varenna Summer School, 1959 (see Abst 15532 of 1961) p. 281-95.

Basic principles of "adding" and "multiplying" two-element interferometers, and their extension to phase-swept and frequenc swept types, are summarized. The fringe patterns obtained with various types of multiple-element system are derived, and illustrative observational results obtained with different systems are given.

P.A.T.W

18153 SOLAR RADIO SPECTROSCOPY.

J.P.Wild.

"Solar radioastronomy", Varenna Summer School, 1959 (see Abst 15532 of 1961) p. 296-312.

The classification of metre-wavelength bursts on the basis of characteristic features of their dynamic spectra is summarized. A review is given of current hypotheses relating to the mechanism of generation of each type, and to their possible connection with flares and terrestrial events.

P.A.T.W

18154 INTERPRETATION OF SOLAR RADIO-OBSERVATIO

C.de Jager.

"Solar radioastronomy", Varenna Summer School, 1959 (see Abst 15532 of 1961) p. 313-64.

A review and discussion is given of observational data concerning the spectrum of the quiet sun, the variation of intensit across the disc and its relation to refraction and scattering in the solar atmosphere, and the spherical asymmetry of the brightness ibution. Observations of the active sun are reviewed, and the lems of assigning suitable mechanisms of generation to the rent burst types is discussed. A brief summary of the theory asma oscillations is given; its usefulness in explaining radiation the corona is considered. P.A.T.Wild

8155 FAST-RESPONSE, NARROW-BAND SPECTROSCOPY.

T.de Groot.

ar radioastronomy", Varenna Summer School, 1959 (see Abstr. 2 of 1961) p. 371-3.

An eight channel receiver (14 Mc/s overall bandwidth) using t recorder was used to study stormbursts (pips). The rence between right- and left-hand polarization was also sured. Storm-bursts in the 300 Mc/s range have a duration 2 sec, a half power width of (7 ± 2) Mc/s and a constant degree larization over their lifetime. G.L.Verschuur

3156 POLARIZATION BEHAVIOUR OF ENHANCED SOLAR RADIO-EMISSION AT 200 MHz.

A.D.Fokker.

ar radioastronomy", Varenna Summer School, 1959 (see Abstr. 2 of 1961) p. 374-84.

In most noise storms the continuum and the storm bursts are rized in one sense only, the individual stormbursts being tical in their degree of polarization, usually 100%. Exceptions, continuum or bursts unpolarized or varying in degree of rization, have been observed. Storms showing mixed polari- on have been attributed to the presence of two noise active ons of opposite polarization. Some second part fare-associated ts have shown strong polarization at their onset, others a ressive development of polarization and some have been larized G.L.Verschuur

8157 SOME NOTES ON NOISE STORMS.

A.D.Fokker.

ar radioastronomy", Varenna Summer School, 1959 (see Abstr. 2 of 1961) p. 385-94.

A general description of the properties of noise storms is n. Measurements of the extent of noise storms were carried vith the solar interferometer at Nera using baselines of 390, and 960 wavelengths. Source diameters were found to be about 6 minutes of arc with a central bright region of 1 to 2 minutes rc. Possibly every sunspot is accompanied by a noise storm h in some cases might be screened by the presence of coronal ctures of sufficiently high electron densities. The source of Mc/s radiation was found to be at a height of 0.4 solar radius h is considerably higher than the level (0.1 solar radius) at h plasma oscillations would produce radiation of this frequency. G.L.Verschuur

8158 THE FREIBURG RADIO SPECTROGRAPH. INSTRUMENT AND PRELIMINARY RESULTS.

H.H.Rabben.

ar radioastronomy", Varenna Summer School, 1959 (see Abstr. 2 of 1961) p. 395-8.

Previously reported in Abstr. 2076, 2084 of 1960.

3159 SOME REMARKS ON TYPE IV.

P.Simon.

ar radioastronomy", Varenna Summer School, 1959 (see Abstr. 2 of 1961) p. 403-7. In French.

A close connection between type IV bursts and solar flares, other solar optical and radio activity, is noted. Solar— estrial relations are briefly discussed. H.Rishbeth

3160 RADIO-OBSERVATIONS OF THE SUN AT MICROWAVE FREQUENCIES.

H.Tanaka.

ar radioastronomy", Varenna Summer School, 1959 (see Abstr. 2 of 1961) p. 408-13.

Observations of the intensity and polarization of radiation in range 1000 to 9400 Mc/s, using both pencil-beam and inter- metric techniques, are briefly described. P.A.T.Wild

3161 GENERAL DISCUSSION ON RADIO-BURSTS.

M.Minnaert.

ar radioastronomy", Varenna Summer School, 1959 (see r. 15532 of 1961) p. 429-36.

18162 SOME REMARKS ON THE POLARIZATION OF 200 Mc/s SOLAR RADIO EMISSION.

M.H.Cohen and A.D.Fokker.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 252-8.

Several instances of weak linear polarization of Type III bursts are reported. Strong circular polarization is rare in this type of burst. Noisestorm radiation on the other hand is generally circularly polarized. The sense of polarization remains constant throughout any one storm. Mixed left and right hand polarization is sometimes observed from active sunspots on the same hemisphere. R.D.Davies

18163 THE 1957 NOVEMBER 4 EVENT.

A.Boischot and A.D.Fokker.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 263-7.

This was a unique metrewave radio solar event which did not appear to coincide with any optical, cosmic ray or geomagnetic phenomena. High speed records showed rapid intensity fluctuations on which were superposed large rises and falls in intensity of several seconds duration. The correlation of details in the noise structure at neighbouring frequencies was small. The variations could have been caused by ionospheric scintillations. R.D.Davies

18164 SLOW DRIFT SOLAR RADIO BURSTS: HARMONIC FREQUENCY RATIOS, SOLAR LONGITUDE DEPENDENCE, AND FREQUENCY DRIFT RATES.

M.B.Wood.

Austral. J. Phys., Vol. 14, No. 2, 234-41 (June, 1961).

Frequency ratios of second harmonic to fundamental bands are determined for 19 slow drift bursts. The ratios measured at the high frequency edges of the bands yield a mean value of 2·00, whereas the mean value of the low frequency edge ratios is significantly lower than 2. No definite solar longitude dependence is observed in either the number of bursts occurring or in the second harmonic to fundamental frequency ratios; further, fundamental bands do not drop out for sources far from the centre of the disk. Frequency drift rates are found to bear no definite relationship to the geomagnetic effectiveness of the bursts.

18165 THE RADIO BRIGHTNESS DISTRIBUTION ON THE SUN AT 21 cm FROM COMBINED ECLIPSE AND PENCIL-BEAM OBSERVATIONS.

T.Krishnan and N.R.Labrum.

Austral. J. Phys., Vol. 14, No. 3, 403-19 (Sept., 1961).

A study of the brightness distribution on the sun at 21 cm wavelength on April 8, 1959, is described. High resolution observations were made of the partial eclipse on that day with a simple radiometer of high sensitivity. The brightness distribution of the uneclipsed sun at the same wavelength was obtained using a cross-grating interferometer, which enabled the bright regions to be located accurately. Considerable similarity is shown to exist between the sizes, shapes and relative intensities of radio bright regions and optical plage faculaires. The radio plages appear to overlie the plage faculaire at a height of about 70 000 km and have temperatures compatible with normal coronal temperatures at that height. The hypothesis that the enhanced radio emission originates thermally from coronal condensations would appear to be upheld. No significant radiation from small sources, which would be visible with the higher resolution, was detected. The quiet-sun distribution for this period of sunspot maximum appears to be similar to that derived by Labrum (1960), i.e. there is limb brightening at the equator but not at the poles, the temperatures being twice the sunspot minimum values. The higher resolution appears to reveal a higher peak temperature and gradient for the limb brightening, which is theoretically to be expected, but which has previously not been observed, probably owing to the smoothing effect of aerials of lower resolution.

18166 DYNAMIC SPECTRA AND PRINCIPAL CHARACTERISTICS OF SHORT-LIVED BURSTS OF SOLAR RADIO EMISSION.

V.V.Vitkevich and M.V.Gorelova.

Astron. Zh. (USSR), Vol. 37, No. 4, 622-30 (July-Aug., 1960). In Russian.

Results are given of an experimental investigation of the principal characteristics of bursts of solar radio emission, made with a multichannel radio spectrograph in the metre wavelength region. A preliminary classification of bursts is given. The bursts are divided into narrow-band P_1, wide-band P_2, and bursts of comparatively long duration L. Data on different types of burst groups P_{g_1}, P_{g_2}, and P_{g_3} are given. [English translation in: Soviet Astron.-AJ (USA), Vol. 4, No. 4, 595-602 (Jan.-Feb., 1961)].

18167 SOLAR RADIO EMISSIONS AND GEOPHYSICAL DISTURBANCES DURING JULY 1959.

M.P.Hughes.

J. geophys. Res. (USA), Vol. 66, No. 2, 651-3 (Feb., 1961).

An analysis is made of spectral observations of solar radio bursts from stations at Fort Davis, Texas and Sydney, Australia. Types II and IV bursts occurring during July 1959 are compared in time relation with other geophysical phenomena. The time delay between flares originating in a particular plage region, and the subsequent magnetic storms, decreased as the region moved across the solar disk. H.J.A.Chivers

18168 A RELATION BETWEEN SOLAR RADIO EMISSION AND LOW-ENERGY SOLAR COSMIC RAYS.

K.Sakurai and H.Maeda.

J. geophys. Res. (USA), Vol. 66, No. 6, 1966-9 (June, 1961).

The relation between solar radio emission and low-energy solar cosmic rays is discussed with reference to 3000 and 200 Mc/s waves emitted from solar flares and observed at Cornell, Nera, Sydney and Tokyo. The results obtained indicate that: (1) there is no relation between the separation in travelling time and the duration of solar radio emission at either frequency; (2) the separation correlates fairly closely to the flux intensity of 3000 Mc/s radio waves whereas no such tendency exists for 200 Mc/s radio emission. The variation of the travelling time, from the sun to the earth, of low-energy cosmic rays and the flux intensity of 3000 and 200 Mc/s waves emitted from flares was also studied. A close connection between the low-energy solar cosmic-ray generation and solar radio emission was indicated. The ejection mechanism of the cosmic rays and their propagation mechanism in interplanetary space is discussed. C.F.Barnaby

18169 SPECTRAL CHARACTERISTICS OF TYPE II SOLAR RADIO BURSTS.

P.A.Sturrock.

Nature (GB), Vol. 192, 58 (Oct. 7, 1961).

Explanations are offered for the existence of comparable radiation powers at the fundamental and second-harmonic frequencies, and for the splitting of these two "lines" into two pairs. P.A.T.Wild

18170 DECIMETRE RADIO BURSTS CONCURRENT WITH SOLAR TYPE IV RADIATION.

T.Krishnan and R.F.Mullaly.

Nature (GB), Vol. 192, 58-9 (Oct. 7, 1961).

Simultaneous measurements of source positions at 1420 Mc/s and in the range 45-60 Mc/s were obtained. The differences in original position and in behaviour with time are interpreted as indicating separate sources for the two types of radiation. P.A.T.Wild

COINCIDENCE OF THE EXPLOSIVE PHASE OF SOLAR FLARES WITH 10.7 cm SOLAR NOISE BURSTS. See Abstr. 18098

18171 THE SOURCE OF RADIATION FROM JUPITER AT DECIMETER WAVELENGTHS. III. TIME DEPENDENCE OF CYCLOTRON RADIATION.

G.B.Field.

J. geophys. Res. (USA), Vol. 66, No. 5, 1395-1406 (May, 1961).

For Pt II, see Abstr. 14383 of 1960. Recent observations of the polarization, spectrum, spatial extent, and time variation of the Jovian decimeter emission are compared with the characteristics of a model based on cyclotron radiation by nonrelativistic electrons trapped in a dipole field. All characteristics but the observed time variation are consistent with a model in which the magnetic field strength at the equator is 0.6 gauss and that at the poles 1.6×10^6 gauss. The field extends to 50 Jovian radii and contains about 3×10^{-5} electrons per cubic centimeter if the electron energy is 40 keV. The problem of time variation is considered theoretically, account being taken of the effects of energy lost through radiation. In particular, the time dependence of the spectrum is calculated for a case when the electrons are injected instantaneously with a given distribution of mirror points. Solutions for arbitrary time dependence of the injection are then found by superposition. The fundamental solution (for instantaneous injection) is found to decay rapidly (in a few days for Jupiter) from a spectrum characteristic of initial conditions to one independent of initial conditions. The observed spectrum of Jupiter cannot be due to the initial phase, because theory indicates that that phase would not last long enough; on the other hand, it cannot be due to the later phase, because theory indicates a much steeper spectrum than is observed. The observed time variation can be reproduced theoretically by a suitable variation of electron injection, but again the theoretica spectrum is much steeper than is observed. It is concluded th the cyclotron model is ruled out by the observations. It seems possible that a model based on synchrotron emission can be ma to explain the time variation while also fitting the other observ characteristics.

18172 RADIO SPECTRUM OF JUPITER.

A.G.Smith.

Science (USA), Vol. 134, 587-95 (Sept.1, 1961).

Review article.

18173 THE DURATION DISTRIBUTION OF METEOR RAD ECHOES. II. REFLECTIONS FROM UNSTABLE TRAILS.

E.I.Fialko.

Astron. Zh. (USSR), Vol. 37, No. 3, 526-9 (May-June, 1960). In Russian.

For Pt I see Abstr. 18679 of 1960. An approximate expres is obtained for the duration distribution of meteor radio echoes received from the characteristic height region, in the case of unstable trails. The character of the distribution of reflections according to duration is determined by the law of distribution o meteor bodies with mass, the velocity of meteoric bodies, and t wavelength of the radar. [English translation in: Soviet Astron AJ (USA), Vol. 4, No. 3, 498-501 (Nov.-Dec., 1960)].

18174 PROPAGATION OF METEOR BURST SIGNALS DUR THE POLAR DISTURBANCE OF NOVEMBER 12-16 1960.

L.A.Maynard.

Canad. J. Phys., Vol. 39, No. 4, 621-3 (April, 1961).

Marked signal black-outs on a meteor burst communication system between Labrador and Ontario using frequencies of 104. Mc/s and 41.3 Mc/s were found to coincide in time with peaks i absorption measured by a 30 Mc/s riometer at mid-path. The effects can be linked on the assumption that the D-region absorb ionization was located mainly below the meteoric region of 80-1 G.M.B

18175 A POSSIBLE EXPLANATION OF THE LONG DURAT RADAR ECHOES OF IONIZED [METEOR] TRAILS I THE UPPER ATMOSPHERE.

C.L.Tang.

J. geophys. Res. (USA), Vol. 66, No. 6, 1974-5 (June, 1961).

It is suggested that if the local electron-plasma frequency is near the frequency of the incident wave, the local wavelength the incident wave may become very large, so that diffusive spreading of ionized trails would be less effective in reducing th radar echo. A simple illustrative model is investigated. M.R.C.McDo

18176 ECLIPSE OF THE CRAB NEBULA.

P.Simon.

"Solar radioastronomy", Varenna Summer School, 1959 (see Abs 15532 of 1961) p. 399-402. In French.

A summary of Nançay observations of the Crab Nebula, dur occultation by the solar corona. At metre wavelengths, the appa diameter of the source increases from 4'.6 to a maximum of 16' during the occultation. H.Rish

18177 THE STRUCTURE OF THE CASSIOPEIA-A AND CYGNUS-A RADIO SOURCES MEASURED AT 127 M AND 3000 Mc/s.

R.C.Jennison.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 309-14.

Phase and amplitude measurements of Cassiopeia-A and Cygnus-A at 127 Mc/s. Cassiopeia-A consists of a source conta ing 90% of the flux and a faint projection at position angle 90°. Cygnus-A is two sources separated by 82 seconds of arc lying or a line at position angle 97°. Measurements at 3000 Mc/s gave a similar brightness distribution to that found at 127 Mc/s. The separation of the Cygnus-A components was 101 seconds of arc lying at position angle 109°. R.D.Da

18178 OPTICAL OBSERVATIONS OF NONTHERMAL GALA RADIO SOURCES.

R.Minkowski.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 315-22.

Nine nonthermal sources near the plane of the Galaxy were identified with nebulosities. The positions and sizes of the sourc and the nebulosities are in satisfactory agreement. At least thre

s of object can be recognized: (1) remnants of supernovae of
I; (2) the Cassiopeia-A source, a remnant of a supernova of
II; (3) the Cygnus Loop and several other large nebulosities
h are most likely of similar origin; they also may be remnants
ipernovae type II. R.D.Davies

8179 THE RADIO SOURCES IN THE CYGNUS LOOP AND IC443. E.M.Burbidge and G.R.Burbidge.

o Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of
) p. 323-7.

The radio emission from the two sources is explained in terms
e synchrotron mechanism. The energy of the emitting cosmic
particles is estimated and is compared with the expected mag-
energy of the medium. A local increase of the galactic
netic field of about 10 times is sufficient to explain the observed
o emission. R.D.Davies

8180 THE ACCURATE POSITIONS OF 17 INTENSE RADIO SOURCES. B.Elsmore.

o Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of
) p. 337-8.

Seventeen sources were observed at a wavelength of 1.9 m
the Cambridge four-aerial interferometer. The sources were
se; the positional accuracy was different for different sources
was in the range 1-5" in R.A. and 2'-10' in Dec. Several
ious provisional identifications were confirmed. R.D.Davies

8181 THE NATURE OF THE RADIO SOURCE CYGNUS-X. F.D.Drake.

o Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of
) p. 339-46.

The continuum radiation from Cygnus-X at about 1390 Mc/s
observed with the Harvard 60 ft. paraboloid having a beamwidth
minutes of arc. Cygnus-X is a complex of many sources some
hich are associated with HII regions seen on the Palomar Sky
s. The minimum distance of the nebulosities is 1500 pc. One of
radio regions is tentatively associated with a nebulosity near the
tar γ-Cygni. R.D.Davies

8182 21 cm HYDROGEN-LINE ABSORPTION IN THE SPECTRA OF DISCRETE SOURCES. C.A.Muller.

o Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of
) p. 360-5.

The absorption spectra of six intense radio sources were
sured with a receiver bandwidth of 5 kc/s (1 km/sec). Many
ow components are seen in Cassiopeia-A, Cygnus-A and
us-A. The minimum r.m.s. velocity broadening of a component
1 km/sec corresponding to a kinetic temperature of 125°K.
R.D.Davies

8183 RADIO EVIDENCE ON THE LARGE-SCALE STRUCTURE OF OUR OWN AND EXTERNAL GALAXIES. [INTRO-
TORY LECTURE TO PART IV—THE LARGE-SCALE STRUC-
E OF GALAXIES]. J.L.Pawsey.

o Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of
) p. 405-8.

Radio observations can distinguish three types of emission -
n line emission, continuum emission from ionised hydrogen
ons and continuum emission from the synchrotron mechanism.
hree forms are found in our own Galaxy and the Magellanic
ds. The continuum emission from our own Galaxy can be re-
ed into a disk and a halo component. R.D.Davies

8184 GALACTIC STRUCTURE AT METER WAVELENGTHS. B.Y.Mills.

o Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960)
1-46.

3.5 metre wavelength radiation from the Galaxy was investigated
a beamwidth of 50 minutes of arc. Galactic radiation has two
r components. The halo component is broadly distributed,
ng an axial ratio of about 1.45 and a central emission of 0.°2 K
parsec. The disk component is concentrated towards the galactic
e, and shows steps in the longitude distribution which are inter-
ed as due to spiral arms. R.D.Davies

8185 ABSORPTION OF 19.7 Mc/s RADIATION IN H II REGIONS. C.A.Shain.

o Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of
) p. 451-9.

The distribution of 19.7 Mc/s radiation was measured within 10° of the galactic plane. The main features of the distribution are the reduced temperatures seen at the position of many H II regions; this effect is due to the absorption of the high temperature background radiation by the H II regions. The non-thermal emission is estimated to be about 100°K per parsec. It is concluded that this emission comes from the spiral arms of the Galaxy. R.D.Davies

18186 GALACTIC BACKGROUND SURVEYS AND THE GALACTIC HALO. J.E.Baldwin.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 460-4.

Surveys of large areas of the sky are made at frequencies of 38 Mc/s and 160 Mc/s, with a resolution of several degrees. The zero level of temperature at 160 Mc/s is known to within approximately ± 8°. A comparison with 2.1 Mc/s results of Reber and Ellis indicates that the optical depth at 100 Mc/s for free—free emission in the interstellar gas of the halo is less than 0.5.
R.D.Davies

18187 CONCLUDING LECTURE [PART IV—THE LARGE-SCALE STRUCTURE OF GALAXIES]. A.Blaauw.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 466-8.

A summary of discussions on the contributions in Part IV is given under the headings of continuum observations of the Galaxy and of extragalactic objects. One problem of great interest is the assessment of the extragalactic contribution to the uniform continuum emission. R.D.Davies

18188 A SURVEY OF RADIO SOURCES AT 3.5 m WAVELENGTH. B.Y.Mills.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 498-506.

The Sydney 3.5 m cross-type radio telescope has a pencil beam with a width of about 50 minutes of arc. 1159 radio sources are dealt with in this paper. There are 20 coincidences between the positions of radio sources and galaxies. 39 strong sources lie near the galactic plane and are most likely of galactic origin. The Class II sources which include a number of extended objects give a plot of log N versus log S with a slope of -1.65. R.D.Davies

18189 COSMIC ELECTRICAL DISCHARGES. III. GALACTIC EVOLUTION AND COSMOLOGICAL CONTROVERSIES.

C.E.R.Bruce.

J. Instn Elect. Engrs (GB), Vol. 7, 430-1 (July, 1961).

For Pt I-II see Abstr. 9289-90 of 1961. The author's electrical discharge theory (see Abstr. 9291 of 1961) postulates the spiral arms of galaxies as the seat of cosmic lightning channels resulting from the breakdown of radial electric fields in the galactic atmosphere. Two factors affecting galactic evolution are emphasized, namely: (1) the condensation of primordial gas and dust prior to the formation of stellar populations; and (2) the build-up, and subsequent breakdown of the galactic electrical field in times of the order of 10^{14} to 10^{15} sec. Hubble's original scheme of nebular evolution from type Eo to type Sc - exactly the reverse of present orthodox ideas - is found to agree with the developmental stages to be expected on the above hypothesis. This result offers direct evidence against the "continuous-creation" cosmological theories, since the larger non-spiral galaxies of types E_0 to E_7 are those in which the electrical field has accumulated for too short a time for breakdown to occur. Thus if the universe has always existed even the largest galaxies will have reached the breakdown stage.
D.R.Barber

18190 COSMIC ELECTRICAL DISCHARGES. IV. THE ENERGY RADIATED BY RADIO GALAXIES.

C.E.R.Bruce.

J. Instn Elect. Engrs (GB), Vol. 7, 513 (Aug., 1961).

Whereas orthodox theoretical studies of the problem of the very large amounts of energy radiated in the radio spectrum of extra-galactic objects yield much lower values than those actually observed, the thermonuclear electrical discharge theory (see preceding abstract) not only accounts for the intense radio emission but,at the same time, gives a correct quantitative estimate of the total energy emitted. Thus, the theory predicts a total energy dissipation of $\sim 10^{60}$ ergs during the lifetime of a radio galaxy as compared with the observed value (for the Virgo A source) of $\sim 10^{58}$ ergs. The agreement between theory and observation confirms the suggestion that the high-temperature (4×10^{8} °K) discharges operating over periods of 10^7 to 10^8 years bring about

the observed difference in constitution of the gaseous matrix from which population 1 stars are ultimately formed.
D.R.Barber

18191 CENTRAL COMPONENT OF THE RADIO SOURCE CENTAURUS A. P.Maltby.
Nature (GB), Vol. 191, 793-4 (Aug. 19, 1961).

Measurements at wavelengths of 21.6 cm and 31.3 cm of the central radio source of Centaurus A using a variable spacing interferometer give a picture of the two components of this source in relation to the wide dust band of NGC 5128, with which it has been associated. The major axis of the source is approximately normal to the dust band and the radiation is found to originate in a region outside the band. The absence of radio emission from the dust band may be explained as due to the dominance of processes such as ionization loss in a region of high gas density. G.M.Brown

18192 SPECTRUM OF GALACTIC RADIO EMISSION. F.G.Smith.
Nature (GB), Vol. 191, 1381 (Sept. 30, 1961).

The experimentally determined value of the spectral index is generally found to be lower than that predicted. New results including one from a satellite-borne receiver at 3.8 Mc/s lead to a value of 0.37. A re-examination of the problem of loss and gain of energy by electrons of cosmic-ray energies is called for.
G.L.Verschuur

AN ATTEMPT TO DETECT THE 327 Mc/s LINE OF GALACTIC DEUTERIUM. See Abstr. 18008

SUBSTRUCTURE WITHIN GALACTIC SPIRAL ARMS AS DERIVED FROM STUDIES AT 21 cm. See Abstr. 18009

NEUTRAL HYDROGEN EMISSION IN THE ORION REGION. See Abstr. 18010

ATOMIC HYDROGEN SURVEY NEAR THE GALACTIC PLANE. See Abstr. 18011

SURVEY OF NEUTRAL HYDROGEN AT HIGH GALACTIC LATITUDES. See Abstr. 18012

POSSIBLE RADIO EMISSION FROM REPEATING NOVAE. See Abstr. 18120

18193 OBSERVATIONS OF EXTRAGALACTIC RADIO EMISSION. C.A.Shain.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 328-36.

Measurements made at frequencies of 19.7, 85.5 and 1390 Mc/s are reported. Centaurus-A is shown to have an extended component about 8° in extent at all these frequencies. Fornax-A is also extended with a diameter of about 100 kiloparsecs. Virgo-A has a faint extended component about 1° in diameter. Observations at the positions of H II regions in the Magellanic clouds at 19.7 Mc/s allow a separation to be made of the galactic halo emission and the emission from beyond the halo; this latter component is about 10 000°K at 19.7 Mc/s. R.D.Davies

18194 RADIO EMISSION FROM THE DIRECTION OF THE SUPERGALAXY. J.E.Baldwin and J.R.Shakeshaft.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p.347-51.

The band of radio emission at 12^h right ascension which has been identified by some observers with the band of galaxies termed the supergalaxy is considered not to come from these galaxies but to be possibly a galactic feature. R.D.Davies

18195 NEUTRAL HYDROGEN IN GALACTIC CLUSTERS. F.D.Drake.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 366-9.

Neutral hydrogen was detected in the galactic clusters h and χ-Persei, the Pleiades, Praesepe and the cluster in Coma Berenices. No hydrogen was found in M67. The results suggest that the neutral hydrogen masses detected are residues of the primordial gas masses from which the clusters were formed. R.D.Davies

18196 75 cm AND 22 cm CONTINUUM SURVEYS. G.Westerhout.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 96
p. 447-50.

The 75 cm survey is plotted for declinations greater than +5°. A number of thermal and non-thermal sources were detected, including the Andromeda nebula and the Coma cluster. The 22 c survey of the galactic plane was used in conjunction with Mill's 3.5 m survey to separate the thermal and non-thermal compone
R.D.Davies

18197 THE DISTRIBUTION AND IDENTIFICATION OF TH SOURCES [INTRODUCTORY LECTURE TO PART V- DISCRETE SOURCES AND THE UNIVERSE]. R.Hanbury Brow
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 471-4.

Radio sources are divided into two classes; class I contain those concentrated toward the galactic plane and therefore of galactic origin, and class II contains those uniformly distribute over the sky and considered to be extragalactic. The distributi of the sources in depth, using number counts by intensity or angular diameter, gives information of cosmological significance. Ident fications with normal galaxies show no significant difference between the radio emission from Sb and Sc galaxies. R.D.Davies

18198 THE OPTICAL IDENTIFICATION OF RADIO SOURC D.W.Dewhirst.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 507-13.

The brighter radio sources of the 3C catalogue are classifi according to their reliability. Of the 20 sources of reliability index A, 14 are identified either certainly or provisionally with external galaxies which are peculiar or are multiple E systems.
R.D.Davies

18199 OPTICAL IDENTIFICATIONS OF SOUTHERN RADIO SOURCES. J.Basinski, B.J.Bok and K.Gottlieb.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 514-22.

An attempt was made to identify 8 radio sources having declinations below -40°; the 74 inch reflector and the Uppsala Schmidt telescope were used. No definite identifications were made with these sources. However at declinations above -40° possible identifications were suggested with the galaxies NGC 31 , 4038/9 and 7171. R.D.Davies

18200 THEORETICAL STUDY OF SYNCHROTRON RADIATION FROM RADIO SOURCES. E.Le Roux.
Ann. Astrophys. (France), Vol. 24, No. 1, 71-85 (1961). In Frenc

The radiation of a charged particle moving in a static magne field, at a relativistic velocity is studied. This calculation was carried out by Schwinger initially in the case of a plane orbit; his results are generalized to an arbitrary orbit, giving the polarization of the radiated wave. A similar computation was done independently by Westfold; however due to the complexity, a somewhat simpler method of calculation is given and carried out little further. It is proved that the ratio of the intensities of the two principal components of the elliptic polarization is exactly equal to seven, independently of the energy of the particle. The ratio of polarization is computed for particles having an isotropic distribution of velocities and an energy spectrum in $E^{-\gamma}$; when $\gamma = 3$, the ratio of the principal components of the radiation for a given frequency, is still equal to seven. Using an expression for the coefficient of absorption calculated previously, that can be use for energetic particles in a radiosource, the theoretical emission spectrum of a radiosource and the cut-offs appearing towards the long and the short wavelengths are studied. This computation justifies some results given by Twiss using a fundamentally differe method which met with some criticisms.

18201 A SKY SURVEY OF NEUTRAL HYDROGEN AT λ 21 cm. I. THE GENERAL DISTRIBUTION AND MOTIONS OF THE LOCAL GAS. R.X.McGee and J.D.Murray.
Austral. J. Phys., Vol. 14, No. 2, 260-78 (June, 1961).

A survey for neutral hydrogen of the whole sky visible from Sydney was carried out with a multichannel H-line receiver and a $2^0 \cdot 2$ aerial beam. A sample of the profiles obtained was analysed to present the disposition of local hydrogen in terms of three schematic diagrams: (1) the distribution of N_H, the number of hydrogen atoms in a line-of-sight column of 1 cm^2 section, (2) a diagram of representative line half-widths, and (3) the observed stribution of profile peak radial velocities. Indications were ınd that the gas is stratified parallel to the galactic plane in neral but with some regions of excess density. From the ientation of the N_H contours it is inferred that the local hydrogen ay have some correlation with the local galactic magnetic field. e line profiles away from the Milky Way were mostly single-aked and of half-widths 12-35 km/sec except in some large gions near the galactic poles where wide profiles of half-widths -140 km/sec were observed. Large-scale grouping of profiles the range from 12 to 20 km/sec occurred, corresponding osely with some of the outstanding features in the N_H distribution. e peak radial velocity distribution showed evidence of differential lactic rotation at middle and low latitudes and lack of data on stance prevented the complete removal of this effect. However, was established that in the solar vicinity hydrogen is flowing twards at a mean radial velocity of +6 km/sec in these latitudes ar the direction of the galactic centre and anticentre. It is wing inwards from above and below in high galactic latitudes at nean velocity of about −6 km/sec.

18202 COUNTS OF EXTRAGALACTIC RADIO SOURCES.

R.Van der Borght.

stral. J. Phys., Vol. 14, No. 2, 295-303 (June, 1961).

A formula is derived giving the cumulative totals of class II dio sources, to successive limits of flux density, when changes the space-density and in the radiative properties of these ırces are taken into account. The formula is then compared with observations and it is shown that it embodies the various empts which have been made so far to explain the −3/2 power /.

18203 A STUDY OF THE REGION OF M17 AT A WAVELENGTH OF 3.75 cm.

R.W.Hobbs.

tron. J. (USA), Vol. 66, No. 9, 517-21 (Nov., 1961).

A study of the region of M17 (NGC 6618) at a wavelength of '5 cm is described. The region was observed with the 85 ft raboloidal aerial with a beamwidth of 5.7 min of arc north—ıth and 6.6 min of arc east—west. The boundaries of the region e R.A. 18^h15^m to 18^h20^m and Dec. $-16°32'$ to $-15°53'$. For the ntral region of the nebula it is shown that the mass is less than)0 solar masses, the r.m.s. electron density is 140 electrons $^{-3}$, the average emission measure is 180 000 pc cm^{-6}, and the x density is 0.76×10^{-23} Wm^{-2} $(c/s)^{-1}$. Some possible exciting ırs are identified. The contours of the central regions suggest pherical shape for the nebula although the positions of the known ssible exciting stars are not consistent with this. A spherical del coincident with the centre of the contours is assumed for centre of the nebula and the electron density distribution is ermined. The electron density distribution so found is ggestive of a Strömgren sphere; however, no exciting star was ntified near the centre. The lack of correlation between the ical and radio shapes of the nebula indicates that the optical tures are strongly affected by absorption. The eccentric sition of the known possible exciting stars, together with the t that the excitation energy available from them is insufficient account for all the ionization that exists, suggests that the ncipal exciting stars have not been found.

18204 THE NATURE OF SUPERNOVAE.

I.S.Shklovskii.

tron. Zh. (USSR), Vol. 37, No. 3, 369-80 (May-June, 1960). Russian.

A method for the determination of the individual distances to panding radio nebulae, that is remnants of outbursts of type II pernovae, is developed, based on the regular decrease in surface ghtness of these objects. An analysis of the space distribution type II supernovae based on this approach shows that the latter nprise of a highly flattened system very reminiscent of the system stars of spectral classes O—B. Some particular cases (e.g., in la) exhibit associations of radio nebulae coinciding with sociations of hot stars. On the basis of an analysis of the quency of outbursts of type II supernovae, of the huge masses of cted envelopes observed, and the space distribution of the remnts of those outbursts, the conclusion is drawn that an important, not the predominant, fraction of stars of spectral classes -B must flare up as type II supernovae. The kinetic energy quired by envelopes of type II supernovae reaches 10^{51} to 10^{52} ergs, ile that of type I supernovae is less by 3 to 4 orders of magnitude. e envelope of the 1572 supernova, and evidently also that of the 4 supernova, has already slowed down appreciably, which places their masses at $M \sim 10^{-2}$ to 10^{-3} solar masses. The ratio of the energy emitted during the outburst to the kinetic energy of the envelope in type I supernovae is a thousand times greater than in type II supernovae. From this, it is inferred that the radiation of type I supernovae is of nonthermal nature (but not necessarily synchrotron radiation), while the nature of the radiation is most likely thermal in the case of type II supernovae. The enormous amount of energy liberated in outbursts of type II supernovae sets severe limitations on the possible conjectures as to the mechanism responsible for the explosion. It is very unlikely that liberation of nuclear energy is involved. The fact that only type I supernovae have been observed in irregular galaxies rich in young and massive stars suggests that those stars which flare up as type II supernovae must form from some diffuse medium enriched with heavy elements. In the early stages of evolution of galaxies, the formation of the heavy elements took place exclusively through outbursts of type I supernovae, which were at that stage tremendously powerful (like Z Centauri) and frequent in occurrence. [English translation in: Soviet Astron.-AJ (USA), Vol. 4, No. 3, 355-64 (Nov.-Dec., 1960)].

18205 INTERFEROMETER MEASUREMENTS OF EXTRAGALACTIC RADIOSOURCES AT 1420 Mc/s IN THE EAST-WEST DIRECTION.

J.Lequeux and J.Heidmann.

C.R. Acad. Sci. (France), Vol. 253, No. 5, 804-6 (July 31, 1961). In French.

18206 8 mm WAVELENGTH RADIO EMISSION FROM THE REGION OF TAURUS-A.

A.D.Kuz'min and A.E.Salomonovich.

Dokl. Akad. Nauk SSSR, Vol. 140, No. 1, 81-3 (Sept. 1, 1961). In Russian.

Two sources were found in the vicinity of Taurus-A, separated by 35 sec in right ascension. Their flux densities are 500×10^{-26} and 130×10^{-26} $Wm^{-2}(c/s)^{-1}$. With an assumed distance of > 3.8 kpc, the diameter of the weaker object is found to be > 3 pc, its electron density < 1000 cm^{-3}, and its mass > 400 solar masses. [English translation in: Soviet Physics—Doklady (USA)].

H.Rishbeth

18207 SECULAR VARIATION OF THE FLUX DENSITY OF THE RADIO SOURCE CASSIOPEIA A.

D.S.Heeschen and B.L.Meredith.

Nature (GB), Vol. 190, 705-6 (May 20, 1961).

Observations made during a three-month period suggest that the 1400 Mc/s flux density of Cassiopeia A is decreasing by about 1% per annum. This is consistent with results at 81.5 Mc/s (Högbom and Shakeshaft, Nature (GB), Vol. 189, 561, 1961).

H.Rishbeth

18208 DISTRIBUTION OF BRIGHTNESS IN EXTRAGALACTIC RADIO SOURCES.

A.T.Moffet and P.Maltby.

Nature (GB), Vol. 191, 453-4 (July 29, 1961).

Interferometer observations using different antenna spacings in both the north—south and east—west directions were made on 180 sources using a radio wavelength of 31.3 cm. Most of the sources greater than 1.5 min arc in extent are apparently asymmetrical and it is suggested that they are in reality, physically linked double sources.

H.J.A.Chivers

18209 AN OUTLINE OF A MAGNETOHYDRODYNAMIC THEORY OF SUNSPOTS.

M.Steenbeck.

Beitr. Plasma Physik (Germany), Vol. 1, No. 3, 153-78 (1960-61). In German.

The processes in a strongly turbulent plasma, in sunspots, is treated from the simple magnetohydrodynamic point of view. The treatment is qualitative and quantitative only in crude approximation.

M.Hasan

18210 CONCLUDING LECTURE. [PART III — GALACTIC AND EXTRAGALACTIC SOURCES].

H.C.van de Hulst.

Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 398-401.

Further identification of radio sources requires a better determination of position, size, brightness distribution, polarization, flux and spectral index. 21 cm studies of the cloud structure in spiral arms have not yet been able to clearly distinguish between a model of discrete clouds or of a random distribution of gas.

R.D.Davies

Space Research

18211 HANDBOOK OF ASTRONAUTICS [Handbuch der Astronautik]. Edited by K.Schütte and H.K.Kaiser.
Konstanz: Akademie Verlagsgesellschaft Athenaion.

The handbook which will eventually consist of four volumes is being issued in sections; each volume will consist of approximately twelve issues. It is intended as a guide to all aspects of the subject and consists of a series of specialist articles.

18212 THE FIRST THREE YEARS OF THE SPACE AGE: A SUMMARY OF SATELLITE LAUNCHINGS.
L.L.van Zyl.
Monthly Notes Astron. Soc. S.Africa, Vol. 20, No. 9, 94-119.

Details are given of satellites, orbits and launching vehicles, covering the three years from Oct. 4, 1957 (launching of Sputnik I).

18213 RESULTS AND PROSPECTS OF SCIENTIFIC RESEARCH IN SPACE. B.Rossi.
Nuovo Cimento Suppl. (Italy), Vol. 19, No. 2, 194-206 (1961).
In Italian.

A paper presented at the 46th Congress of the Italian Physical Society outlining in elementary terms four possible applications of space vehicles for scientific research. The four problems discussed are the exploration of the moon and planets within the solar system, the study of the origin and nature of the electromagnetic radiations, unmasked by effects introduced by the atmosphere and the ionosphere, the correlation of further information about the earth obtained outside terrestial influence, and the study of space itself from observation of the flux of particles as a function of their nature and energy, and of electric and magnetic fields in the immediate neighbourhood of the vehicle. S.J.St-Lorant

18214 THE EFFECT OF SOLAR RADIATION PRESSURE ON THE MOTION OF AN ARTIFICIAL SATELLITE.
R.W.Bryant.
Astron. J. (USA), Vol. 66, No. 8, 430-2 (Oct., 1961).

The effects of solar radiation pressure on the motion of an artificial satellite are obtained. The results include the effects produced by the intermittent acceleration which results from the eclipsing of the satellite by the earth. Vectorial methods were utilized to obtain the nonlinear equations describing the motion and the method of Krylov—Bogolyubov was applied in their solution.

18215 FORMULAE FOR AN ACCURATE INTERMEDIARY ORBIT OF AN ARTIFICIAL SATELLITE. J.P.Vinti.
Astron. J. (USA), Vol. 66, No. 9, 514-16 (Nov., 1961).

Formulae are given for computing the drag-free orbit of an artificial satellite of an oblate planet moving in the field of a certain gravitational potential. This potential, expressed in oblate spheroidal coordinates and leading to separability of the Hamilton—Jacobi equation, fits the zeroth and second zonal harmonics exactly and, in the case of the earth, yields more than half the fourth zonal harmonic. The solution gives periodic terms through the second order in the oblateness parameter and secular terms exactly, for the given potential. It thus furnishes an intermediary orbit which should always remain very accurate.

18216 EFFECTS OF THE EQUATORIAL ASYMMETRY OF THE EARTH ON THE ORBIT OF AN ARTIFICIAL SATELLITE. H.Robe.
Bull. Soc. Roy. Sci. Liege (Belgium), Vol. 30, No. 9-10, 427-30 (1961). In French.

It is shown how long-periodic and resonance terms arise, due to the ellipticity of the earth's equator. Long-periodic terms do not exist when equatorial orbits are considered.

18217 THE DETERMINATION OF THE OSCULATING ORBIT OF AN ARTIFICIAL EARTH SATELLITE.
P.Kustaanheimo.
Comment. phys.-Math. (Finland), Vol. 26, No. 1, 25 pp. (1961).
In German.

The author's method (Abstr. 9256 of 1961) of preliminary orbit determination using high speed digital computers is adapted to give the osculating elements of the orbit from these observations made at one (or more) observing stations during one satellite transit. Two collections of formulae are given: one of them gives all six elements of the orbit, the other gives the remaining five elements if the orbital period (or the semi-major axis or the total energy of the orbit) is assumed known. Both methods are illustrated by numerical examples from Finnish observations of Soviet satellites. It is shown additionally that the determination of the osculating orbit from three observations always has one and only one solution, in the case of both a general and an energy-conditioned.

18218 THEORY OF AN ACCURATE INTERMEDIARY ORBIT FOR SATELLITE ASTRONOMY. J.P.Vinti.
J. Res. Nat. Bur. Stand. (USA), Vol. 65B, No. 3, 169-201 (July-Sept., 1961).

Derives an accurate intermediary orbit of an artificial satellite of an oblate planet. The drag-free motion takes place under the action of a gravitational potential which fits the even zonal harmonics exactly through the second and approximately through the fourth in the case of the earth. This potential leads to separability of the Hamilton—Jacobi equation. Two alternative sets of orbital elements are set forth. The first set is related directly to initial conditions, but requires numerical factoring of a certain quartic to evaluate some of the integrals. The second set, on the other hand, permits exact factoring of both quartics that appear, but is not related directly to initial conditions, so that its members can best be obtained by a least-square fit of the solution over many orbital revolutions. The final solution is given in terms of certain uniformizing variables, whose periodic terms are correct through the second order in the oblateness parameter and whose secular terms are exact, for the intermediary orbit. These exact solutions for secular terms are expressed by means of certain rapidly converging series, with complete avoidance of elliptic integrals of the third kind.

18219 GENERALIZATION OF SINGER'S FORMULA FOR THE GENERAL RELATIVISTIC RED SHIFT TO ELLIPTIC SATELLITE ORBITS. S.Refsdal.
Phys. Rev. (USA), Vol. 124, No. 4, 996 (Nov. 15, 1961).

See Abstr. 1042 of 1957. The average rate difference between a clock on the earth and a clock in an "elliptic satellite" is found to be dependent only on the average specific kinetic energy $\bar{T}$ of the satellite and the average gravitational potential of the satellite, $\bar{\chi}_s$. By means of the virial theorem, $\bar{T}$ and $\bar{\chi}_s$ are shown to be dependent only on the major axis, 2a, of the satellite orbit, giving the result:

$$\bar{\Delta} \equiv (\tau_s - \tau_E)/\tau_E = 6.96 \times 10^{-10}(1 - 3r_E/2a),$$

where τ_s and τ_E are the periodic times read on the satellite clock and the earth clock, respectively, and r_E is the radius of the earth.

18220 THE CONTRACTION OF SATELLITE ORBITS UNDER THE INFLUENCE OF AIR DRAG. II. WITH OBLATE ATMOSPHERE. G.E.Cook, D.G.King-Hele and D.M.C.Walker.
Proc. Roy. Soc. A (GB), Vol. 264, 88-121 (Oct. 24, 1961).

For Pt I see Abstr. 52 of 1961. The effect of air drag on satellite orbits of small eccentricity e (< 0.2) was studied in part I on the assumption that the atmosphere was spherically symmetrical. Here the theory is extended to an atmosphere in which the surfaces of constant density are spheroids of arbitrary small ellipticity. Equations are derived which show how perigee distance and orbital period vary with eccentricity, and how eccentricity is related to time. Expressions are also obtained which give lifetime and air density at perigee in terms of the rate of change of period. In most of the equations, terms of order e^4 and higher are neglected. The results take different forms according as the eccentricity is greater or less than about 0.025, while circular orbits are dealt with in a separate section. The influence of atmospheric oblateness is difficult to summarize fairly, because it depends on four independent parameters. If these simultaneously assume their "worst" values, some of the spherical-atmosphere results can be altered by up to 30% as a result of oblateness. But usually the influence of atmospheric oblateness is much smaller, and 5 to 10% would be a more representative figure.

18221 LIFETIMES OF ORBITING DIPOLES. I.I.Shapiro and H.M.Jones.
Science (USA), Vol. 134, 973-9 (Oct. 6, 1961).

An account of the West Ford experiment. It is suggested that sunlight pressure will limit the average orbital lifetime of the dipoles to about seven years.

18222 CRYOGENIC ROCKET PROPELLANTS.
I.E.Smith.
ogress in cryogenics, Vol. 3 (see Abstr. 13029 of 1961)
75-95.

This review discusses the basis of the rocket engine, its rformance relationships and the criteria for the selection of opellants. Cryogenic chemical propellant systems are compared th nuclear and free radical propellants. The problems and strumentation associated with cryogenic propellants in rocket gines are considered. J.B.Birks

18223 COMMENT ON WYATT'S ANALYSIS OF CHARGE DRAG. D.B.Beard and F.S.Johnson.
geophys. Res. (USA), Vol. 65, No. 10, 3491-2 (Oct., 1960).

The authors' analysis (Abstr. 10538 of 1960) of the charge drag a satellite is defended against Wyatt's criticisms (Abstr. 473 of 1960). Wyatt calculates the charge drag as the small fference between two large and approximate quantities and finds to be independent of the ionospheric ion density and inversely pendent on the area of the satellite surface. These features are ysically unacceptable. D.M.Gilbey

18224 THE DRAG ON A CHARGED SATELLITE.
A.L.Licht.
geophys. Res. (USA), Vol. 65, No. 10, 3493 (Oct., 1960).

(See preceding abstract). Wyatt has omitted the largest ntribution to the drag, namely that due to the ions actually riking the satellite surface. The number of such ions varies th the electric charge on the satellite, so that these impacts ake a contribution to the charge drag. D.M.Gilbey

18225 THE NATIONAL PROGRAM FOR LUNAR AND PLANETARY EXPLORATION. A.R.Hibbs.
geophys. Res. (USA), Vol. 66, No. 7, 2003-12 (July, 1961).

The National Aeronautics and Space Administration has assigned the Jet Propulsion Laboratory the responsibility for design and velopment of spacecraft for the exploration of the moon, the nets, and interplanetary space. In carrying out its assignment, L, the United States' oldest guided-missile and rocket-research oratory, is designing and fabricating spacecraft to be flown past e moon and to land scientific equipment on the surface of the moon. signs have also begun for spacecraft to fly past the planets and d capsules of scientific instruments on the planetary surfaces. is paper describes the Ranger spacecraft, now undergoing sembly, which will initiate the lunar exploration programme; the riner, now being designed, which will initiate the planetary ogramme with a flight past Venus; and the Surveyor, in which ckages of scientific instruments will be soft-landed on the moon.

18226 20 Mc/s W.W.V. BURSTS DURING THE LAST FEW PERIODS OF 1958δ2. J.Wolfe.
atmos. terrest. Phys. (GB), Vol. 22, No. 3, 176-85 (Nov., 1961).

Paper recordings of w.w.v. on 20 Mc/s were taken during the st 8 days of Sputnik III (1958δ2). The satellite was tracked during s period with an h.f. direction finder. This paper describes the ethods used in trying to correlate w.w.v. enhancements with the sition of the satellite. The results indicate that if Sputnik III oduced detectable reflections, its ability to do so was nearly, if t completely, independent of the satellite's position.

18227 ALTERNATION OF THE LIGHT [REFLECTED] FROM THE ROCKET-CASE OF SPUTNIK III.
Notni and H.Oleak.
natsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 1,
. 7-10, 394-6 (1959). In German.

During its orbital flight, the cylindrical rocket-case rotated d-over-end to give two light maxima per revolution. The epochs these maxima would depend on the relative positions of sun, server, and rocket-case, and on the spatial position of the rotation s of the latter. An observed daily increase in the rotation riod, Δ P, is considered in relation to the observed corresponding crease in the orbital period, Δ T, of the rocket-case, and these rameters are each expressed in terms of the two periods, P and by an empirical equation. This is used to compute a theoretical ue of the ratio ΔP/ΔT which is compared with the observed value, /ΔT = 0.0124 s/3.040 s. Assuming that the difference between served and computed values of the ratio is due to magnetic drag, naximum value of 0.0075 s per day is found for the geomagnetic celeration. D.R.Barber

18228 ON TRACKING OF SPACE VEHICLES BY THE DOPPLER EFFECT. R.M.Evan-Iwanowski.
Ricerca sci. (Italy), Vol. 30, No. 12, 2397-406 (Suppl. Dec., 1960).

Two methods of the determination of position and velocity vectors of space vehicles moving in the central gravitational force field from the Doppler data were presented. One method deals with the case when the Doppler observations are available over some interval of time or for a few adjacent times from one observation station, and another method when the Doppler observations are made by a few stations at various geographic locations. The combination of the two methods is also possible. The Doppler tracking of powered space vehicles, and the Doppler tracking using moving observation stations (satellite stations) is discussed.

CONSIDERATIONS IN THE DESIGN OF A NUCLEAR ROCKET.
See Abstr. 17181

18229 THE APPLICATION OF MIRROR-LENS OBJECTIVES FOR PHOTOGRAPHING ARTIFICIAL EARTH SATELLITES. N.V.Yakovlev.
Astron. Zh. (USSR), Vol. 37, No. 3, 550-4 (May-June, 1960).
In Russian.

Brief dimensional data and the main optical characteristics of a high-speed mirror-lens objective are given. The objective makes possible the photography of artificial earth satellites of the sixth magnitude on film with a sensitivity of about 500 $\text{lux}^{-1}\ \text{sec}^{-1}$. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 3, 523-7 (Nov.-Dec., 1960)].

18230 THE THEORY OF AUTOMATIC SATELLITE TRACKING TELESCOPES. M.Liigant and Ya.Éinasto.
Astron. Zh. (USSR), Vol. 37, No. 6, 1087-95 (Nov.-Dec., 1960).
In Russian.

Some problems connected with the design of automatic telescopes for tracking satellites are considered. In section 1 different types of mounting for a satellite tracking telescope with a fixed or movable polar axis are considered. In section 2, formulae are given for the apparent motion of a satellite, and for the corrections to the position of a satellite, taking account of the earth's rotation. In section 3, the possibility of using circular orbits for approximating to the apparent orbit of the satellite is discussed. The deviations of the circular orbits from the true elliptic orbit are shown in a diagram. In section 4, the approximation to the satellite's apparent orbit by a small circle is discussed, the corresponding deviations from the true trajectory being given. In this case, the polar axis of the telescope should be directed towards the pole of the apparent orbit of the satellite. This can be attained by using a mounting with two additional axes. In section 5, the approximation to the satellite's apparent orbit by a great circle is considered, the corresponding deviations being given. Some problems connected with satellite photography are also discussed. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 6, 1023-31 (May-June, 1961)].

18231 BEHAVIOUR OF UNPERTURBED SYSTEMS IN AN INERTIAL SPACE. V.A.Bodner and V.P.Seleznev.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 5, 1043-6 (June 11, 1961).
In Russian.

For abstract, see Abstr. 15585 of 1961 [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 6, 476-9 (Dec., 1961)].

18232 DROPOUT PHENOMENON OBSERVED IN THE SATELLITE 1958 δ_2 TRANSMISSIONS. L.Liszka.
J. geophys. Res. (USA), Vol. 66, No. 5, 1573-7 (May, 1961).

The paper discusses the occurrence of sudden interruptions of satellite transmissions. The phenomenon is attributed to irradiation of the satellite's quartz crystal oscillator, and it is concluded that γ-rays associated with the "horns" of the outer radiation zone are responsible. H.Rishbeth

18233 A TRANSATLANTIC COMMUNICATION EXPERIMENT VIA ECHO I SATELLITE. W.C.Jakes, Jr.
Nature (GB), Vol. 190, 709 (May 20, 1961).

A note giving numerical data relating to the transatlantic reception of 960 Mc/s signals by Carru et al. (Abstr. 8030 of 1961), with a comment by the latter. H.Rishbeth

PHYSICS

GENERAL

18234 CONTRADICTION AND ITS REMOVAL IN THE DEVELOPMENT OF PHYSICS. M.Strauss.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 7, 409-12 (1960). In German.

A brief review of several developments in physical theory viewed from the philosophical standpoint indicated in the title.

P.T.Landberg

18235 THE USE OF ALGEBRAIC STRUCTURES IN PHYSICS. C.W.Kilmister and D.J.Newman.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 4, 851-64 (Oct., 1961).

The hypothesis of the existence of abstract structures in physics, which has been made in recent papers, is made precise. Difficulties in previous formulations are removed and insight into Maxwell electrodynamics is obtained. General relativity is related to other field theories which deal with flux from sources, and new field equations for general relativity are proposed.

18236 H.BOEGEHOLD. E.Wandersleb.
Optik (Germany), Vol. 18, No. 7, 326-38 (July, 1961). In German.

An account of his life and work to mark his eighty-fifth birthday.

18237 C.A.SONNEFELD. H.Slevogt.
Optik (Germany), Vol. 18, No. 8, 403-5 (Aug., 1961). In German.

An account of his life and work to mark his seventy-fifth birthday.

18238 UNITS OF WEIGHT AND MEASURE (UNITED STATES CUSTOMARY AND METRIC): DEFINITIONS AND TABLES OF EQUIVALENTS. L.V.Judson.
Misc. Publ. Nat. Bur. Stand. (USA), No. 233, 62 pp. (1960).

The units of length, area, volume, capacity, and mass in the United States are defined. Tables of interrelation and tables of equivalents for these units in the metric system and in the U.S. customary system are given. All values in the text and in the tables have been revised to be in accord with the Federal Register announcement of July 1, 1959, an announcement entitled "Refinement of values for the Yard and Pound" in accordance with an agreement among the directors of National Standards Laboratories of English-speaking nations to obtain uniformity in precise measurements involving the yard and the pound. The long tables were all recomputed on an automatic computer and printer. This is a revision of Miscellaneous Publications 214 (1955).

18239 DIMENSIONS OF ELECTRICAL AND MAGNETIC QUANTITIES. A.E.Martin.
Nature (GB), Vol. 191, 588-9 (Aug. 5, 1961).

The author suggests that the mass of a body should be expressed in terms of the number of electrons, protons and neutrons (a neutron contributing one of each). Hence the mass of a body will have a definite relationship to the number of the elementary charges, and $[F] = [q^2 L^{-2}]$ where F is the gravitational force of attraction between two masses and [M] in the gravitational equation is replaced by [q]. This leads to $[q] = [M^{1/2} L^{3/2} T^{-1}]$ a result obtained by other methods. The author then briefly discusses several other cases.

E.G.Knowles

THE IDEA OF SIZE IN LARGE-SCALE PHYSICS.
See Abstr. 18005

18240 SYSTEMATIC ERRORS IN PHYSICAL CONSTANTS. W.J.Youden.
Phys. Today (USA), Vol. 14, No. 9, 32-4, 36, 38, 40-3 (Sept., 1961).
Review article.

COSMOLOGICAL IMPLICATION OF PHYSICAL CONSTANTS.
See Abstr. 18006

18241 ON THE QUESTION OF "SIMPLICITY" OF LINEAR FIELD LAWS. N.R.Sen.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. Suppl. 2, 125-32 (Dec., 1960).

Einstein expressed the belief that natural laws can be formul through the simplest possible mathematical ideas. An attempt is made to follow this idea out by a consideration of linear wave fiel Relativistic formalism is adopted.

GRAVITATION . RELATIVITY

18242 GENERAL INVESTIGATION OF THE RELATION IN CURVED SPACE BETWEEN INVARIANCE AND CONSERVATION, IN CLASSICAL FIELD THEORY. E.Schmutzer.
Z. Naturforsch. (Germany), Vol. 16a, No. 8, 825-35 (Aug., 1961). In German.

For a curved space, the relation between invariance under continuous transformations and conservation is studied for a gene classical field theory described by a Lagrangian of the second ord From the infinitesimal invariance of the Lagrangian up to a divergence-like term which may be admitted for greater generalit many relations are derived, representing a generalized version of the Noether theorem. The formulation is given in such a general manner that it can be immediately applied to all physically significant types of continuous symmetry. Detailed consideration is mad of the relation of conservation laws in curved coordinate systems those in Minkowski coordinates. For fields of a general geometri type, a direct proof is given concerning the identity of the Belinfa energy complex and the symmetrical energy complex. In connecti with this problem the transformation properties of the metrical spin-tensors for infinitesimal coordinate transformations are derived. The developed formulae are applied to a field system consisting of the electromagnetical field and nonlinear spinor field of Heisenberg type.

18243 A SIMPLE NORMAL FORM FOR THE GRAVITATION FIELD IN THE FIRST APPROXIMATION.
A.Papapetrou.
Ann. Phys. (Germany), Vol. 8, No. 5-6, 260-9 (1961). In German.

Working in terms of the contravariant tensor density, it is shown that asymptotically Minkowskian first-order solutions of th vacuum field equations may be reduced by coordinate transformat to a "normal" form for which the isothermal coordinate condition satisfied.

R.A.New

18244 A UNIQUENESS THEOREM CONCERNING GRAVITY FIELDS. R.A.Smith.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 4, 865-70 (Oct., 1961).

A given external (Newtonian gravitational) field can obviously be produced by a variety of mass systems. It is shown that the conditions (i) that the system is formed by filling a bounded open set G with mass of density $\rho = \rho\ (x,y)$, where ρ is a bounded, measurable, strictly positive function, (ii) that lines parallel to $z = o$ meet G if at all in a single line-segment, together with some further set-theoretical restrictions, are sufficient to make the fie determine the mass distribution. This improves and extends a result of Sretenskiĭ [Dokl. Acad. Nauk SSSR, Vol. 99, 21-2 (1954)]

C.W.Kilmis

18245 ON THE POSSIBILITY OF RECORDING GRAVITATIO RADIATION UNDER LABORATORY CONDITIONS.
V.B.Braginskii and G.I.Rukman.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1, 304-5 (July, 1961). In Russian.

Weber's suggestion (Abstr. 6655 of 1960) that elastic longitud waves in a cylinder produce gravitational waves of comparative large intensity, suffers from the fact that measurements are limit by large noise figures. It is suggested that several parallel cylin

ergized synchronously (either all in phase or some in anti-phase the remaining) would produce a registrable field in the presence noise. [English translation in: Soviet Physics—JETP (USA)].
J.K.Skwirzynski

LAGRANGIAN FORMALISM FOR A CLASSICAL RELATIV-TIC PARTICLE ENDOWED WITH INTERNAL STRUCTURE.
ee Abstr. 16666

18246 ON PLANE WAVE SOLUTIONS OF FIELD EQUATIONS IN GENERAL RELATIVITY. H.Takeno.

ensor (N.S.), Vol. 7, 97-102 (1957).

The author determines new solutions of the Einstein field quations for a space-time with a metric of the form

$$ds^2 = -A(dx^2 + dy^2) - B(dz^2 - dt^2),$$

here A and B are functions of $Z = x - t$. The energy tensor is ken to be that of a Maxwell field $F_{\mu\nu}$ with no charges or currents resent such that

$$F_{12} = F_{34} = 0$$

nd the remaining components of $F_{\mu\nu}$ are functions of Z alone. The uthor does not make use of the simplification B = 1 which can be ade by a coordinate transformation.
Mathematical Reviews (A.H.Taub)

18247 ON THE RELATIVISTIC ANALYTICAL DYNAMICS OF A PARTICLE. Pham Mau Quan.

cta phys. Austriaca, Vol. 14, No. 2, 232-8 (1961). In French.

The formulation of relativistic dynamics to be found in (e.g.) ynge: Geometrical mechanics and de Broglie waves (Cambridge, 954) (Abstr. 6311 of 1954) is specialized by assuming as Lagrangian ynge: medium function)

$$L = (E - V) (g_{\alpha\beta}\dot{x}^{\alpha}\dot{x}^{\beta})^{1/2}.$$

C.W.Kilmister

18248 ENERGY, MOMENTUM AND ANGULAR MOMENTUM IN THE GENERAL THEORY OF RELATIVITY.

.Dautcourt.

nn. Phys. (Germany), Vol. 8, No. 5-6, 309-17 (1961). In German.

The energy and momenta are derived for static fields from a agrange density involving terms linear in $g_{\alpha\beta,\gamma}$ and dependent upon vo constants a_1 and a_2; the special cases $a_1 = 1$, $a_2 = -\frac{1}{2}$, and $_1 = a_2 = 0$, give the Einstein and the Lorentz—Klein densities. The nergy and angular momentum of the field for a closed system is ompatible with special relativity theory only if $a_1 + a_2 = \frac{1}{2}$.
R.A.Newing

18249 A CLASS OF DYNAMICAL QUANTITIES. A.Uhlmann.

cta. phys. Hungar., Vol. 13, No. 1, 75-88 (1961). In German.

General dynamical quantities are defined for an arbitary etric, and the problem of conservation laws is discussed. elations with classical theories are considered, and the fact that certain set of conservation laws reduce, for a Minkowski metric, o the ten first integrals of mechanics suggests an obvious way of riting down commutation rules.
C.W.Kilmister

18250 GEOMETRICAL AND PHYSICAL INTERPRETATION OF THE WEYL CONFORMAL CURVATURE TENSOR.

A.E.Pirani and A.Schild.

ull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, o. 7, 543-7 (1961).

The geometrical interpretation is in terms of the behaviour of ongruences of null geodesics. The corresponding physical inter-retation, in the space—time of general relativity, provides in rinciple, a means for the measurement of physical components of he Weyl tensor with light rays alone, without the use of clocks or igid rods.
F.A.E.Pirani

18251 PETIAU—DUFFIN—KEMMER THEORY IN GENERAL RELATIVITY. A.Lichnerowicz.

.R. Acad. Sci. (France), Vol. 253, No. 7, 983-5 (Aug. 16, 1961). n French.

The author's tensor and spinor propagators are used to extend he theory of particles of spin 0 and 1 to the case of a general pace-time.
R.A.Newing

18252 A NOTE ON WAVE SOLUTION OF EINSTEIN'S UNIFIED FIELD THEORY. N.N.Ghosh.

Calcutta Mathmatical Society Golden Jubilee Commemoration Volume (1958-59) Part I. p. 179-84 [Calcutta Mathematical Society, Calcutta-9, India].

Some special exact solutions of the equations

$$g_{\underset{+-}{\mu\nu};\sigma} = 0, \quad \Gamma_{\mu} = 0, \quad R_{\mu\nu} = 0,$$

are found including one with plane symmetry.
C.W.Kilmister

18253 TRAJECTORIES IN THE UNIFIED FIELD THEORY. J.Levy.

Acta phys. Hungar., Vol. 13, No. 1, 1-9 (1961). In French.

From a Lagrangian for the Einstein—Schrödinger theory one can find four identities which lead, with the help of the field equations, to the trajectories of particles.
C.W.Kilmister

18254 STATIC ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY. III. B.K.Datta.

Ann. Phys. (USA), Vol. 15, No. 3, 403-10 (Sept., 1961).

For previous work, see Abstr. 8049 of 1961. The equations of the "already unified theory" as given by Raychaudhuri (Abstr. 4252 of 1961) for static electromagnetic fields are considered for the case in which the diagonalized metric tensor components are functions of two coordinates only. Some special solutions are obtained and the nonexistence of some types of solutions is demonstrated.

18255 THE FIVE-DIMENSIONAL REPRESENTATION OF PARTICLES OF SPIN 2, 1 AND 0. S.Lederer.

C. R. Acad. Sci. (France), Vol. 252, No. 25, 3946-8 (June 19, 1961). In French.

The particle equations are derived from a five-dimensional variational principle. The symmetric tensor field involved is interpreted in terms of the linearized equations of the Jordan—Thiry theory.
R.A.Newing

18256 BIRKHOFF'S THEOREM FOR ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY. A.Das.

Progr. theor. Phys. (Japan), Vol. 24, No. 4, 915-16 (Oct., 1960).

Exact solutions for combined electromagnetic and gravitational field equations with non-static spherical symmetry are obtained. Besides electric fields, the contributions of the magnetic pole are included. It is shown that the solutions may be transformed to the static form, and thus Birkhoff's theorem is extended from the purely gravitational case to the combined electromagnetic and gravitational case [see Relativity and Modern Physics. G.D.Birkhoff. Cambridge, Mass: Harvard University Press (1923)].
Vachaspati

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

18257 QUANTUM THEORY AND PHILOSOPHY. M.Strausss.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 7, 402-9 (1960). In German.

Quantum field theory, relativistic quantum mechanics, non-relativistic quantum mechanics, and classical mechanics are compared as regards their scope, and with reference to the special cases which are contained in each theory.
P.T.Landsberg

18258 INVARIANCE OF PLANCK'S CONSTANT IN REVISED RELATIVITY OF J. PALACIOS. A.H.Klotz.

Progr. theor. Phys. (Japan), Vol. 25, No. 5, 860-1 (May, 1961).

It is shown that Palacios's conclusion [Revista de la Real Academia de Ciencias Exactas, Fisicas y Naturales de Madrid (Spain), Vol. 51, 21-101, 165-83, 245-92, 405-27 (1957)], that is no longer invariant under his assumptions does not follow.
C.W.Kilmister

18259 **A SOLUBLE MODEL IN QUANTUM FIELD THEORY: THE WENTZEL MODEL.** G.Rideau.
Ann. Inst. Poincare (France), Vol. 17, No. 2, 91-128 (1961).
In French.

Continuation of earlier work (Abstr. 3136 of 1959). For each case cited there, the structure of the Hilbert space and the method of obtaining the physical creation and destruction operators are examined. When there are bound states or pathological states, there is no canonical transformation between free operators and physical operators. J.E.Paton

18260 **THE INTEGRAL REPRESENTATIONS OF JOST, LEHMANN AND DYSON.**
V.S.Vladimirov and V.F.Nikitin.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 4, 809-12 (June 1, 1961).
In Russian.

For abstract, see Abstr. 15672 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 6, 463-5 (Dec., 1961)].

18261 **CANONICAL VARIABLES IN RELATIVISTIC QUANTUM THEORY.**
K.Bardakci and R.Acharya.
Nuovo Cimento (Italy), Vol. 21, No. 5, 802-10 (Sept. 1, 1961).

A simple general method is presented for the explicit determination of the operator corresponding to "position" in any relativistic one-particle theory. It works in all the well-known cases.

18262 **QUANTUM PHENOMENA IN OPTICAL IMAGES.** R.S.Ingarden.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 7, 549-52 (1961).

An attempt is made to bridge the gap between quantum physics and classical optical theory. From the wave-function of a single photon, the classical Helmholtz equation of classical diffraction theory is derived. Possibilities of further development of this theory are pointed out. R.W.Fish

18263 **ONE-PARTICLE GREEN'S FUNCTION IN THE SPINOR SPACE.** J.Rzewuski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 11-12, 777-82 (1960).

Solutions of the second order invariant differential equation in spinor space are examined. It is found that the linear equation in spinor space has solutions corresponding to solutions of nonlinear equations in Minkowski space, and it is shown how one-particle Green functions in quantum field theory can be constructed from solutions of the linear equation. D.J.Thouless

18264 **TWO-PARTICLE GREEN'S FUNCTION IN THE SPINOR SPACE.** J.Rzewuski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 11-12, 783-7 (1960).

It is shown that coupled linear invariant differential equations of second order in spinor space have solutions that correspond to two-particle Green functions in quantum theory. It is suggested that this may provide a new approach to problems in quantum field theory. D.J.Thouless

18265 **SECOND ORDER INVARIANT DIFFERENTIAL EQUATION IN THE SPINOR SPACE.**
J.Mozrzymas and J.Rzewuski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 3, 225-8 (1961).

It is shown that the general second order invariant equation in spinor space is an analytic continuation of the special case treated in an earlier paper (see preceding abstract). D.J.Thouless

18266 **GAUGE COVARIANCE OF SPINOR GEOMETRY.** A.Peres.
Nuovo Cimento (Italy), Vol. 21, No. 1, 182-3 (July 1, 1961).

It is shown that in Cartesian coordinates the covariant derivatives of the pseudospinors in the Dirac equation involve a vector whose real part can be related to the electromagnetic potentials. Vachaspati

18267 **NON-LINEAR QUANTIZATION OF A SPINOR EQUATION.** D.S.Chernavskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1360-5 (May, 1961).
In Russian.

A non-linear spinor equation of the Heisenberg type is considered. The proposed procedure for determining the "mass" values of th eigenstates of the spinor field is based on the following assumpti s: (a) the number of "entrance" and "exit" lines on the diagrams de- cribing the eigenstates of the field are sufficiently large; (b) only irreducible diagrams are taken into account. The procedure is carried out by means of the self-consistent field method. [Engli translation in: Soviet Physics—JETP (USA)].

18268 **ON THE SCHRÖDINGER EIGENVALUE PROBLEM.** O.Hellman.
K. Danske Vidensk. Selsk. mat.-fys. Medd. (Denmark), Vol. 32, No. 10, 15 pp (1960).

In Pt I (Abstr. 6681 of 1960) it was required that $\sqrt{(2l + 1)^2 + k}$ was not an integer, a condition which is now dropped. The eigenvalue problem is again reduced to the formation of a series whos terms are obtained by a simple process the main operation of wh is the integration. The formulae contain the potential $V_0(r)$ as su The eigenvalues appear as roots of rapidly converging power ser the eigenfunctions are expressed in terms of functions obtained i the process of forming the power series. The method is applicable also to the case where the mass is a function of r.

18269 **FORMULAE FOR NON-DEGENERATE RAYLEIGH—SCHRÖDINGER PERTURBATION THEORY IN ANY ORDER.** R.Huby.
Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 529-36 (Oct., 1961).

It is shown that Bloch's solution for the n-th-order perturbat of the energy and the eigenvector in the Rayleigh—Schrödinger perturbation theory of non-degenerate, discrete levels can be expres in a different form, of a kind suggested by Brueckner, and some a- vantages of the latter form are presented.

18270 **THE SIGNIFICANCE OF ENERGY COMPARISON FO THE ACCURACY OF AN APPROXIMATE SOLUTION [OF THE SCHRÖDINGER EQUATION].** H.Preuss.
Z. Naturforsch. (Germany), Vol. 16a, No. 6, 598-602 (June, 1961).
In German.

Different tests of accuracy in approximation are discussed a it is shown that a comparison of energies is not a sufficient criterion for the goodness of a wave-function. The use of local energies is proposed as a variation procedure, which provides a general definition of goodness and in the first approximation gives better expectation values than are possible by means of energy variation. R.G.C.Arric

18271 **ON THE IMPOSSIBILITY OF NON-LINEAR TRANSFORMATIONS OF SCALAR MASSLESS WAVE EQUATION.** Vachaspati.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 4, 355-8 (July 26, 1960).

It is shown that the wave equation $\Box^2\phi = 0$ does not admit of a nonlinear transformations of the wave function ϕ, and, consequent the widest group of coordinate transformations under which it is invariant is the conformal group discussed already in a previous paper by the author and Mohan Jauhari (Abstr. 13313 of 1961).

18272 **ON THE COULOMB WAVE FUNCTIONS.** Z.Janković.
Period. math.-phys. astron. (Yugoslavia), Vol. 2, No. 4, 279-95 (1960).

Summarizes well-known basic theory of these wave functions, and relevant properties of confluent hypergeometric functions. J.Hawgo

18273 **ELECTRON POLARIZATION OPERATORS.** D.M.Fradkin and R.H.Good, Jr.
Rev. mod. Phys. (USA), Vol. 33, No. 2, 343-52 (April, 1961).

A summary of formal aspects of polarization operators. The three-vector and four-vector polarization operators are defined: algebraic properties, eigenfunctions, and density matrices are discussed. The transformation to the Foldy—Wouthuysen represen ation is given. Extensions to external field problems and anomalou magnetic moment effects are also considered. Various results on the classical equations of motion for spin are summarized. T.Erber

18274 **NORMALIZATION OF THE WAVE-FUNCTIONS OF QUASISTATIONARY STATES.** A.M.Dykhne and A.M.Dykhne and A.V.Chaplik.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1427-8 (May, 1961).
In Russian.

A method for determining the norm of quasistationary states i esented which is not dependent on the assumption of spherical mmetry of the potential and is simplier than that proposed by l'dovich(Abstr. 3403 of 1961). [English translation in: Soviet ysics—JETP (USA)].

18275 THE TRANSFORMATION PERMUTATION GROUP MATRIX AND CONSTRUCTION OF THE COORDINATE VE FUNCTION OF A MULTISHELL CONFIGURATION.
.Kaplan.
. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 560-8 (Aug., 1961). Russian.

An orthogonal representation of the permutation group with an bitrary type of reduction on the subgroups is considered. A ansformation matrix between representations with various types reduction is introduced which to a certain degree is an analogue the transformation matrix between various coupling modes of gular momenta. A method for calculation of the matrix in terms the matrix elements of the standard Young—Yamanouchi presentation is presented. An expression is given for the ordinate wave-function of a multi-shell configuration in terms of e vector-coupled coordinate wave-functions of the separate shells. nglish translation in: Soviet Physics—JETP (USA)].

18276 WHY DO PROBABILITIES INTERFERE?
A.Landé.
Phys. (Germany), Vol. 164, No. 5, 558-62 (1961). In German.

The wavelike interference law connecting various transition obabilities, usually taken as the expression of a basic and reducible quantum dualism, is derived as a consequence of the stulate that a general connection law between the probabilities ists at all, together with requirements of symmetry, invariance, d other features of a non-wavelike nature. Duality is thus vested of its fundamental character, and a way is found to derstand quantum mechanics on a non-quantal basis.

THE BEHAVIOUR OF THE SPIN OF DIRAC PARTICLES IN OLLISION PROCESSES. See Abstr. 16658

18277 DISSIPATION IN QUANTUM MECHANICS. THE HARMONIC OSCILLATOR. II. I.R.Senitzky.
hys. Rev. (USA), Vol. 124, No. 3, 642-8 (Nov. 1, 1961).

The development of a quantum-mechanical formalism for ystems with dissipation that was presented in Pt I (Abstr. 14519 of 960), and intended mainly for application to the electromagnetic eld in a cavity, is extended. The problem of the harmonic scillator with dissipation is shown to be the same as that of a armonic oscillator coupled to a thermal reservoir, and the need of e formalism to contain the appropriate statistical mechanics is iscussed. The derivation of relationships which permit the calcula- ion of all moments of the oscillator coordinate and momentum rovides the necessary extension of the theory. The formal esemblance of the completed theory to that of classical Brownian otion, some differences due to quantum mechanics, and the fact at certain fundamental relationships which are assumed in the atter are derived in the present analysis, are pointed out. The pplication of the theory is illustrated by the consideration of three roblems: the proof of Ott's formula, and the derivation of both the robability density and energy distribution of the oscillator in quilibrium with a thermal reservoir.

18278 ENERGY LEVELS OF THE BOUNDED ISOTROPIC HARMONIC OSCILLATOR AND THE BOUNDED YDROGEN ATOM BY THE METHOD OF BOUNDARY PERTURBA- ION. K.K.Singh.
roc. Nat. Inst. Sci. India A, Vol. 27, No. 1, 86-94 (Jan. 26, 1961).

It is shown that the theory of boundary perturbation can be uccessfully used to investigate the quantum mechanical behaviour f the bounded isotropic harmonic oscillator and the bounded ydrogen atom for large values of the boundary parameter. nalytical expressions are obtained to represent the energy levels o the second order of approximation. The first order results are dentical with those derived by Dingle [Proc. Cambridge Phil. Soc. GB), Vol. 39, 103 (1953)] and by Hull and Julius (Abstr. 8004 of 956) from different considerations.

18279 ON THE QUANTIZATION OF PHYSICAL SPACE-TIME OPERATORS. II. I.Watanabe.
rogr. theor. Phys. (Japan), Vol. 26, No. 1, 7-21 (July, 1961).

The characteristic features of the theory proposed in Pt I Abstr. 10422 of 1961) are analysed by using the interaction representation. It is shown that this theory gives the same result for the transition matrix as conventional field theory. The latter is thus regarded as the true form of the present theory.

18280 QUASICLASSICAL QUANTIZATION IN THE NEIGHBOURHOOD OF SINGULAR CLASSICAL TRAJECTORIES. M.Ya.Azbel'.
Zh. eksper teor. Fiz. (USSR), Vol. 39, No. 5(11), 1276-85 (Nov., 1960). In Russian.

It is shown that in general the only singular trajectories in phase space which are important in thermodynamics are trajectories which are self-intersecting. Such trajectories necessarily exist if the potential well has several minima. In the case of a metal in a magnetic field this corresponds to a non-convex bounding Fermi-surface. The system of equations for these cases is found and it is shown that near the point of self-intersection the separation between levels contains a part which oscillates with the magnetic field. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 891-7 (May, 1961)].

18281 ANGULAR VARIATION OF AXIAL SPIN-HAMILTONIAN EIGENVALUES IN STRONG MAGNETIC FIELD.
H.A.Buckmaster.
Canad. J. Phys., Vol. 39, No. 7, 1073-9 (July, 1961).

General expressions and tables are given which allow a calculation of the energy of transition between levels with strong field quantum numbers M and M−m up to $\Delta M = \pm 6$. These tables are useful in discussing the results of r.f. spectroscopy and the operation of masers. D.J.Oliver

18282 THE MATHEMATICAL EQUIVALENCE OF THE BORN APPROXIMATION AND THE METHOD OF IMPACT PARAMETERS. A.M.Arthurs.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 4, 904-5 (Oct., 1961).

Analyses Frame's work (Abstr. 1274 of 1932) showing that the impact parameter approximation tends to the Born approximation at high energies and weak interactions for collisions involving s—s transitions. The argument is shown to be erroneous, but the same result is obtained in a different way, using Hankel transforms. F.Herbut

AN EXAMPLE OF A SCATTERING SYSTEM IN JANCH'S SENSE. See Abstr. 16691

18283 THERMODYNAMICS OF THE ISOLATED PARTICLE. L.de Broglie.
C.R. Acad. Sci. (France), Vol. 253, No. 9, 1078-81 (Aug. 28, 1961). In French.

The causal interpretation of quantum mechanics and the theory of the double solution are used to show how thermodynamic quantities can be defined for a single particle, and how Hamilton's principle is related to the principle of maximum entropy. J.Hawgood

STATISTICAL MECHANICS TRANSFER PROCESSES

18284 DYNAMICAL DERIVATION OF EQUILIBRIUM CORRELATIONS FOR DENSE FLUIDS IN STATISTICAL MECHANICS. F.C.Andrews.
Physica (Netherlands), Vol. 27, No. 11, 1054-60 (Nov., 1961).

Starting with the equation given by the Brussels group for low-order correlations in a dynamical system, the following properties are proved: Among the many contributions arising, any which contains an articulation point vanishes at equilibrium if the intermolecular potential possesses inversion symmetry. A special case of this theorem is the constancy of the velocity distribution under collisions at equilibrium due to detailed balancing. Derivation of the general Ursell—Mayer equilibrium theory of dense fluids follows immediately.

18285 EXPANSION OF THE LINEAR BOLTZMANN OPERATOR. A.Siegel.
Progr. theor. Phys. (Japan), Vol. 25, No. 6, 1049-51 (June, 1961).

The Kramers expansion is rearranged to form the "CD expansion", which operates on a transformed distribution function $P(y,t)\exp(y^2/4)$, P being the usual distribution function for thermal fluctuations of the variable y. C and D are creation and destruction operators for Hermite functions of y. Successive terms of the expansion can be interpreted directly as successive kinetic-theory corrections. The relation of the new expansion to the topics of Abstr. 16622 of 1960 is discussed. J.Hawgood

18286 EHRENFEST'S URNS AND FIRST ORDER STOCHASTIC PROCESSES. C.George.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 47, No. 2, 92-110 (1961).
In French.

Two stochastic processes are considered, one in which balls are transferred from one urn to the other urn, and one in which balls are removed from or added to both urns at the same time. The stochastic equations obtained for these two models are solved, using Krawtchouk and Meixner's orthogonal polynomials. D.ter Haar

18287 CORRELATION PROBLEMS IN EVOLUTIONARY STOCHASTIC PROCESSES.
A.Ramakrishnan and T.K.Radha.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 4, 843-7 (Oct., 1961).

In a previous contribution (Ramakrishnan (1)) (Abstr. 15 of 1951) the concept of product density was introduced to describe the statistical distribution of a discrete number of particles in a continuous space E, corresponding to a single point t, where t is the parameter with respect to which the stochastic process evolves. This is extended to densities corresponding to n points on the t axis and correlation problems associated with these density functions are studied with particular reference to electron—photon cascades.

18288 VISCOUS FORCES AND BROWNIAN MOTION. N.Takeyama.
J. Phys. Soc. Japan, Vol. 16, No. 5, 1030-1 (May, 1961).

An attempt to link up the "molecular dynamical" and "thermodynamical ensemble" theories of Brownian motion, based on two slightly different interpretations of the friction constant. H.N.V.Temperley

POWER SPECTRUM COMPUTATION TECHNIQUE APPLIED TO THE BROWNIAN MOTION OF A PARTICLE WITH IDEALIZED COULOMB DAMPING. See Abstr. 17981

18289 FORMULATION OF STATISTICAL MECHANICS IN TERMS OF OCCUPATION NUMBERS. II.
R.Balian, C.Bloch and C. De Dominicis.
Nuclear Phys. (Internat.), Vol. 27, No. 2, 294-322 (Oct., 1961).

For Pt I see Abstr. 12810 of 1961. A physical interpretation of the generalized free energy F, introduced in Pt I in connection with the variational principle, is obtained by relating it to the statistical distribution of the occupation numbers. The values of the occupation numbers derived from the variational principle are then interpreted as the most probable values in a grand canonical ensemble of identical systems. As a particular consequence of the theory, it is shown that in the case of an infinite system without Bose condensation, the probability distribution of any occupation number has the same form as in the absence of interactions. The classical limit of the theory is then considered. First, the great similarity of the results with the classical expansions expressed in terms of the local density is exhibited by re-deriving the well-known classical expressions with the methods of Pt I. Finally the classical limit of the Gibbs potential is shown to be identical, term by term, with the classical virial expansion.

18290 REVERSIBILITY AND IRREVERSIBILITY IN LINEAR PASSIVE SYSTEMS. J.Meixner.
Z. Naturforsch. (Germany), Vol. 16a, No. 8, 721-6 (Aug., 1961).
In German.

Linear passive systems are defined by a set of mathematical properties; ohmic resistances and harmonic oscillators are among this class of systems. Their properties are discussed, and their spectral function is introduced. The connection between the spectral function and irreversible behaviour is discussed. D.ter Haar

18291 MEMORY EFFECTS IN IRREVERSIBLE THERMODYNAMICS. R.Zwanzig.
Phys. Rev. (USA), Vol. 124, No. 4, 983-92 (Nov. 15, 1961).

A new generalization of Onsager's theory (1931) of irreversible processes is presented. The main purpose is to allow for memory effects or causal time behaviour, so that the response to a thermodynamic force comes later than the application of the force. This is accomplished by a statistical mechanical derivation of an exact non-Markoffian kinetic equation for the probability distribution in the space of macroscopic state variables. The memory effect in the resulting transport equations is represented by a time convolution of the thermodynamic forces with memory functions. The latter are time-correlation functions in the rates of change of the phase functions corresponding to macroscopic quantities. The resulting transport equations are not restricted to small deviations from thermal equilibrium. Onsager's theory is shown to be the low-frequency limit of the present causal theory.

18292 ENTROPY, MARKOV PROCESSES AND BOLTZMAN H-THEOREM. P.A.P.Moran.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 4, 833-42 (Oct., 19

Considers a Markov chain with a finite number of states $E_1 \ldots E_n$ and a matrix of transition probabilities for discrete tim such that after a fixed, finite number of steps any state is accesib from any initial state. It is well-known that, with $\phi(x) = -x\ln x$,

$$S = \sum_{i=1}^{n} \phi(p_i)$$

is a never-decreasing function of time. The same result is true $\phi(x)$ is a continuous convex function of x for $x \geq 0$. Boltzmann's H-theorem involves a similar result for the function $-f\ln f$ of th velocity distribution function f. The question arises: could one this case establish monotonic behaviour for convex functions oth than $-f\ln f$? It is shown here that for a statistical model, analog to the gas case but with a finite number of particles and a finite number of particle states, the only convex differentiable function the probabilities which possesses monotonic properties is indeed $-x\ln x$. The essential features of the model are (1) a quadratic master equation for probabilities (analogous to the Boltzmann equation); (2) the assumption that the result is to be true for arbitrary transition probabilities, subject of course to the usual reciprocity conditions. It is pointed out that the restriction (2) prevents application to the Boltzmann case, where the transit probabilities are not arbitrary. R.O.Dav

18293 FLUCTUATION THERMODYNAMICS OF NON-EQUILIBRIUM PROCESSES. R.L.Stratonovich.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1647-59 (Dec., 196
In Russian.

A connection is established between the two-dimensional distribution of equilibrium fluctuations and the one-dimensional distribution of a non-equilibrium process. As a consequence of this relation the equations of the theory of equilibrium fluctuatio and of non-equilibrium thermodynamics are derived. It is shown that the residual correlations and the ergodicity of the system ar determined by the behaviour of its thermodynamic functions. In correspondence with this, the Onsager relations are generalized for the case of nonlinear non-equilibrium. [English translation i Soviet Physics—JETP (USA), Vol. 12, No. 6, 1150-8 (June, 1961)]

STATISTICAL THERMODYNAMICS OF PLASMAS.
See Abstr. 18815

18294 QUANTUM STATISTICAL MECHANICS. DENSITY OPERATORS AND THERMODYNAMIC QUANTITIES.
J.Yvon.
J. Phys. Radium (France), Vol. 21, No. 7, 569-74 (July, 1960).
In French.

Calculates the single density operator and the double density operator for the equilibrium case as a function of t and the activi

18295 THE PHYSICAL MEANING OF NEGATIVE PROBABILITIES.
Zh-P.Vizh'e [J.P.Vigier] and Ya.P.Terletskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 508-12 (Feb., 1961).
In Russian.

It is shown that the calculation of the statistical averages of series of physical quantities can be carried out with the help of t distribution function instead of the probability density. The distribution function is the mathematical expectation of the parti density and is proportional to the probability density for a single particle only if all particles are absolutely identical. For a set

icles and antiparticles (with respect to some single property)
listribution function can also assume negative values. In this
it is no longer proportional to the probability, but it can be
l to compute the averages of a number of physical quantities.
shown that in the field theory of elementary particles, the
age values of some quantities characterizing the entire field
rgy, momentum, charge, etc.) can be computed with the help of
corresponding distribution function. [English translation in:
et Physics—JETP (USA), Vol. 13, No. 2, 356-9 (Aug., 1961)].

8296 THE THEORY OF NEUTRAL AND IONIZED GASES. THE PROBLEM OF n BODIES AT NON-ZERO
IPERATURE. [La théorie des gaz neutres et ionisés. Le
lème des n corps à température non nulle].
ed by C.De Witt and J.F.Detoeuf.
s: Hermann; New York: John Wiley (1960) 469 pp. In English
French.
For abstracts of the papers in the above Volume see Abstr.
8-26 of 1961.

.8297 CONFIGURATION INTERACTION FOR WAVE FUNCTIONS BUILT UP FROM ORTHOGONAL TWO-
ECTRON ORBITALS. E.Kapuy.
a phys. Hungar., Vol. 12, No. 4, 351-7 (1960).
Describes a variational procedure for obtaining two-electron
itals as approximations to those defined in Abstr. 4261 of 1961,
shows how a configuration-interaction expansion might be
structed from the almost-complete, almost-orthogonal set of
ti-electron wave-functions so obtained. The general methods
applied to approximations based on antisymmetrized products of
one-electron orbitals, and connections with other approaches
ablished. J.Hawgood

18298 COMPARISON OF TWO MODELS FOR THE MANY-FERMION SYSTEM. E.M.Henley and L.Wilets.
. Phys. (USA), Vol. 14, No. 1, 120-42 (July, 1961).
Comparisons are made between the state of many-fermion
tem periodic in space discussed by Overhauser (Abstr. 11125 of
0) and the state with paired plane waves proposed by Bardeen,
per and Schrieffer (Abstr. 1708 of 1958). It is found that, even
he one-dimensional case, where the periodic state can be set
most easily, the paired state yields the lower energy with the
active potentials used here. A state that consists of paired
iodic functions is also used as a trial wave function, and is found
give less binding than a paired plane-wave state. It is concluded
t the two possible effects are competing, and that the pairing
ect is generally stronger. D.J.Thouless

18299 KINETICS OF COOPERATIVE PROCESSES. M.V.Vol'kenshtein, Yu.Ya.Gotlib and O.B.Ptitsyn.
. tverdogo Tela (USSR), Vol. 3, No. 2, 420-8 (Feb., 1961).
Russian.
This paper is essentially concerned with approximate methods
solution of the equations of motion of systems of interacting
ments. These are based on neglecting interactions of more than
ertain number of elements together. First and second-order
roximations are discussed in detail, and results of numerical
culations for a specific case are presented. [English transla-
n in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 306-12
61)]. N.L.Johnson

18300 ON THE DIAMAGNETISM OF A SYSTEM OF INTERACTING PARTICLES. I.G.Kaplan.
. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1053-5 (Oct.,
60). In Russian.
It is shown that the diamagnetic susceptibility of a system of
eracting particles is independent of their interaction up to terms
order h^2. [English translation in: Soviet Physics—JETP (USA),
l. 12, No. 4, 733-4 (April, 1961)].

18301 MANY-ELECTRON THEORY OF ATOMS AND MOLECULES. O.Sinanoğlu.
oc. Nat. Acad. Sci. (USA), Vol. 47, No. 8, 1217-26 (Aug., 1961).
Compares the many-body problem in nuclei, in electron gases,
l in atoms and molecules, and the techniques used in these
ferent fields and their efficacy when transferred from one to
other, and outlines the author's technique for obtaining wave
ctions taking account of correlations in N-electron atoms and
lecules. This method uses two-electron corrections to the
rtree—Fock wave function, and it is shown, by careful discussion
and by comparison with Watson's Be wave function (Abstr. 13392 of 1960), that three and four electron collisions are negligible. It is shown how the chemical picture of atoms and molecules may be preserved in this formulation, in spite of the effects of correlation. J.Hawgood

18302 THE USE OF LAPLACE TRANSFORMS FOR EVALUATING THE PARTITION FUNCTION. A.A.Zaitsev.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1258-62 (Nov., 1960). In Russian.

The problem of evaluating the partition function can be reduced to the problem of finding the trace of the operator $(\hat{H} + p)^{-1}$, where $\hat{H}$ is the energy operator and p a complex parameter, if one uses Laplace transforms. This fact can be used to find the partition function for a fairly wide class of energy operators $\hat{H}$ in the form of a power series in $1/kT$. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 878-80 (May, 1961)].

18303 EXCITATION SPECTRUM OF A PARTICLE SYSTEM IN AN EXTERNAL FIELD. V.M.Eleonskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1143-7 (April, 1961). In Russian.

A set of equations defining the excitation spectrum and decay of the initial individual excitation is derived from the linearized Hartree equations by taking the initial conditions into account. The quantum dispersion relation and its classical analogue, which specify the collective excitation spectrum of a system in an external field, are deduced. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 804-7 (Oct., 1961)].

18304 CONTRIBUTION TO THE THEORY OF LOCALIZED PERTURBATIONS IN LARGE SYSTEMS. V.I.Osherov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1166-71 (April, 1961). In Russian.

An evaluation is made of the energy shift for the ground state of a large Fermi system when a localized perturbation is switched on, taking the interaction between the particles in the system into account. The energy levels of the localized states are then broadened into bands. A condition is established for the applicability of single-particle approximations to the description of states of this kind. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 820-3 (Oct., 1961)].

18305 THE MOMENTUM DISTRIBUTION OF PARTICLES IN A DILUTE FERMI GAS. V.A.Belyakov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1210-12 (April, 1961). In Russian.

The first two terms of the expansion in powers of the gas parameter of the momentum distribution of particles in a non-ideal Fermi gas are obtained, using a perturbation method. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 850-1 (Oct., 1961)].

18306 THE MOMENTUM DISTRIBUTION FUNCTION OF A FERMI-PARTICLE GAS IN THE HIGH-DENSITY LIMIT.
I.O.Kulik.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1343-52 (May, 1961). In Russian.

A gas consisting of Fermi particles interacting according to Coulomb's law is investigated at zero temperature by field-theory methods. The interaction lines and propagation lines of free particles are renormalized and this permits one to take into account correlation and exchange effects of the interaction. The momentum distribution of the particles $(T = 0)$ is calculated in the high-density approximation (Gell-Mann—Brueckner approximation). The applicability of the high-density approximation for describing electron interaction in metals is discussed. [English translation in: Soviet Physics—JETp (USA)].

THEORY OF MANY-PARTICLE SYSTEMS. SUPERCONDUCTIVITY. See Abstr. 18699

THE TREATMENT OF MANY-PARTICLE PROBLEMS IN QUANTUM CHEMISTRY BY MEANS OF THE GAUSS INTEGRAL TRANSFORM. See Abstr. 17250

18307 AN APPROXIMATE SOLUTION OF A GENERALIZED STATISTICAL MODEL. K.Ladányi and P.Szépfalusy.
Acta phys. Hungar., Vol. 13, No. 2, 145-53 (1961).

A variational method is presented for the solution of statistical equations derived by the authors independently of each other. A nonlinear system of integro-differential equations is given for the radial density D_l of the electrons of azimuthal quantum number l. The variational method introduced here reduces the number of equations. The method is applied to the determination of the electron density of the A atom; the agreement with Hartree's results (1938) is satisfactory.

18308 ON C AND P INVARIANCE OF A FERMION.
K.H.Tzou.

J. Phys. Radium (France), Vol. 21, No. 8-9, 674-5 (Aug.-Sept., 1960). In French.

It is shown that a fermion field is invariant under C and P separately if these transformations for the field operators are defined in a suitable way. It is pointed out that this conclusion does not hold either for two-component Dirac fields or for interactions of fields. F.Herbut

18309 CHARGED BOSON GAS.
L.L.Foldy.

Phys. Rev. (USA), Vol. 124, No. 3, 649-51 (Nov. 1, 1961).

The ground-state energy and elementary excitations of a charged gas of bosons at high densities are examined by use of the method developed by Bogoliubov (1947) for boson gases. It is conjectured, but not established here, that this method yields exact results in the high-density limit analogous to those obtained by Gell-Mann and Brueckner (Abstr. 6372 of 1957), and by Sawada (Abstr. 6374 of 1957) in the corresponding case of a charged fermion gas. The ground-state energy is essentially correlation energy, and is therefore negative, and its magnitude varies as the one-fourth power of the density at high densities. The elementary excitations have for low momenta the energy appropriate to plasma waves, and for high momenta the energy appropriate to single-particle excitation. There is therefore an energy gap, suggesting that the gas is both a superfluid and a superconductor at low temperatures. At low densities the behaviour of a charged gas is independent of statistics; hence, such a gap must disappear as the system is expanded.

18310 SOME CONSIDERATIONS OF ANALYTICITY IN THE MANY-FERMION PROBLEM. J.S.Langer.

Phys. Rev. (USA), Vol. 124, No. 4, 997-1003 (Nov. 15, 1961).

The analytic properties of Feynman amplitudes in the many-fermion problem are investigated by means of techniques developed for use in field theory e.g. Landau (Abstr. 5469 of 1960) and Cutkosky (Abstr. 17216 of 1960). A prescription is given for calculation of discontinuities across branch cuts. This prescription leads to a reformulation of the theory in terms of quasi-particles; but considerations of unitarity are no longer so simple as they are in field theories dealing with stable particles. These analytic methods turn out to be very useful in electron transport problems.

18311 THE EQUATION OF STATE OF HARD SPHERES.
E.Byckling.

Physica (Netherlands), Vol. 27, No. 11, 1030-6 (Nov., 1961).

The configurational integral Q of a system of hard molecules can be approximately expressed as a function of the configurational integral Q_1 of a one-dimensional system. Q_1 can be evaluated when the molecules are parallel cubes. This gives an approximative equation of the state for hard spheres. Using the known virial coefficients of the hard sphere gas, the three first terms of the series expansion of Q_1 for hard spheres are evaluated. Thus gives a slightly different form of the equation of state. The configurational integral Q can be expressed as a function of the probability P(n) of the possibility of placing a molecule at a random point in a region containing n − 1 previous molecules. The function P(n) is calculated by the Monte Carlo method and a group of points of the equation of state is evaluated.

18312 SOME COMMENTS ON THE REACTION MATRIX FOR A MANY-BOSON SYSTEM. W.E.Parry.

Physica (Netherlands), Vol. 27, No. 11, 1045-53 (Nov., 1961).

Some doubts are expressed on the usefulness of the conventional reaction matrix for many-boson systems whose densities are not low. It is suggested that the modified reaction matrix of Nozières and Pines approaches zero for low momenta so that the low-momentum linear portion of the excitation spectrum is lost, and the condition for the existence of superfluidity is no longer obeyed. A way out of this difficulty is suggested, but it is pointed out that there is no good reason for thinking that the reaction matrix is a useful quantity for high density systems.

18313 PARTICLE—HOLE BOUND STATES IN THE MANY FERMION SYSTEM. T.Gotô.

Progr. theor. Phys. (Japan), Vol. 26, No. 1, 84-98 (July, 1961).

Bound states of a particle—hole pair are investigated by m of the Bethe—Salpeter equation. Besides the well-known densit oscillation, it is shown that transverse collective oscillations a possible. The conditions for the existence of a transverse wave studied.

18314 ON THE THEORY OF THE MAGNETIC PROPERTIE OF A NONIDEAL FERMI GAS AT LOW TEMPERATURES. I.A.Akhiezer and S.V.Peletminskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11),1308-16 (Nov., In Russian.

The methods of quantum field theory are used to study the of the interaction between particles on the oscillations of the magnetic moment of a Fermi gas. The forces between the parti are assumed to be of the short-range type, and the calculations are made in the gas approximation. Values are found for the changes of period and amplitude of the oscillations of the magne moment that are caused by the interaction between particles. A not too low temperatures the amplitude of the oscillations conta a factor that decreases exponentially with decrease of the magn field. [English translation in: Soviet Physics—JETP (USA), Vol No. 5, 913-18 (May, 1961)].

18315 PHOTON TRANSPORT THEORY.
R.K.Osborn and E.H.Klevans.

Ann. Phys. (USA), Vol. 15, No. 2, 105-40 (Aug., 1961).

A first order, momentum-configuration space transport eq for photons is derived for low energy (nonrelativistic) systems. derivation is first order in the sense that the transition probabi characterizing photon scattering emission and absorption are c puted only to the first nonvanishing order by conventional pertu tion methods. The present aprroach provides an essentially ax deduction development of the theory of radiative transfer (albei several ill-evaluated approximations) within the context of whic various processes and their interrelationships may be investiga Most of these processes have hitherto been studied only phenom ologically and usually piecemeal. Specific application to photon scattering, cyclotron radiation, recombination radiation, de-exc tion radiation, and bremsstrahlung is made in the text. The der tion of an H-theorem for photon—particle systems is sketched; contact is made with the usual statistical mechanical treatment the equilibrium states of such systems. It is also shown that so aspects of collective particle behaviour can be introduced quite naturally into the description of photon transport in the fully ion plasma.

18316 CORRECTION TO THE SUBJECT MATTER OF A PREVIOUS NOTE ["INFLUENCE OF THE TRANSFE OF HEAT UPON THE TRANSFER OF MASS IN THE CASE OF T RECTIFICATION OF BINARY MIXTURES"]. E.Ruckenstein.

C.R. Acad. Sci. (France), Vol. 253, No. 11, 1204 (Sept. 11, 1961) In French.

See Abstr. 10448 of 1961.

18317 ON THE STATISTICAL PROPERTIES OF SOME TRANSPORT EQUATIONS. A.E.Scheidegger.

Canad. J. Phys., Vol. 39, No. 11, 1573-82 (Nov., 1961).

It is shown that, whenever a system is a linear combinatio a large number of fluctuating component systems and in the "la system a certain quantity is a constant of the motion, under equilibrium conditions that quantity is canonically distributed i the component systems and, under non-equilibrium conditions (assuming linear regression of the fluctuations and microscopi reversibility), the quantity in question is subject to a diffusivity equation with a symmetric diffusivity tensor. Application of th above to porous media hydrodynamics immediately yields the equations for miscible displacement which were laboriously obtained earlier from a special statistical model. Similarly, th corresponding equations for suspended sediment transport in r and for the mixing of a pollutant in air are shown to be the resu of an application of the above general statement. Finally, the theory is also applied to the inertial frequency range in the statistical theory of turbulence.

318 A STANDARD FORMULATION OF THE STEADY CONVECTIVE MASS-TRANSFER PROBLEM.

Spalding.
nat. J. Heat Mass Transfer (GB), Vol. 1, No. 2-3, 192-207 ., 1960).

It is shown that, provided that certain relations exist between ransport properties, every mass transfer problem, including e with simultaneous heat transfer and chemical reaction, can xpressed by relations of the "Ohm's Law" type: $\dot{m}'' = g . B$, e $\dot{m}''$ is the required mass transfer rate through the ace, g is a surface conductance dependent on aerodynamic rs, and B is a dimensionless driving-force dependent on the modynamic properties of the main stream, of the fluid in act with the phase boundary, and of the transferred substance. standard formulation is derived from the differential equations nservation and flux and by reference to a wall-flux boundary lition. Thereafter examples are given of methods of calculating llowed by examples of expressions for B valid for particular s.

3319 THE RELAXATION OF A SYSTEM WEAKLY COUPLED TO A THERMOSTAT. J.Yvon.

hys. Radium (France), Vol. 21, No. 6, 505-13 (June, 1960).
rench.

Employs a quantum mechanical treatment, in which the rtance is emphasized of the non-diagonal elements of the sity operator. Starting from the hypothesis of initial chaos, the elations between two weakly coupled systems are treated by a urbation method. The example is examined of a simple system led to a thermostat, giving equilibrium relaxation times and inear phenomena.

8320 THE FOKKER—PLANCK EQUATION.
N.G. van Kampen.

Tijdschrift Natuurkde (Netherlands), Vol. 26, No. 8, 225-38 ., 1961).

In this review article the Fokker—Planck equation is derived the master equation; it is then applied to the case of a heavy s moving in a one-dimensional gas (Rayleigh's particle), to wnian motion, to diffusion, and to fluctuations in semiconductors. e final section the validity of the Fokker—Planck equation is ussed. D. ter Haar

8321 DERIVATION OF THE BOLTZMANN TRANSPORT EQUATION FOR INELASTIC COLLISIONS.

.Argyres.
hys. Chem. Solids (GB), Vol. 19, No. 1-2, 66-72 (April, 1961).

A quantum-mechanical derivation of the Boltzmann transport ation for inelastic collisions is given along the lines Kohn and inger have developed for elastic collisions (Abstr. 5866 of 1958). shown that for Fermi—Dirac particles the scattering in the ision term of the transport equation is restricted to unoccupied es only, contrary to the case of elastic collisions.

8322 NONLINEAR EFFECTS IN TRANSPORT THEORY.
J.A.McLennan, Jr.

s. of Fluids (USA), Vol. 4, No. 11, 1319-24 (Nov., 1961).

A method for the formal statistical description of transport cesses beyond the linear approximation is discussed. External es which maintain a deviation from equilibrium are introduced the Liouville equation, and solution of this equation yields an mble characteristic of the nonequilibrium state. The transport tions are obtained with the aid of the resulting ensemble. For plicity, the discussion is restricted to heat flow, but the generalion to the processes of viscosity and diffusion is straightforward.

8323 ON THE THEORY OF SCATTERING OF SLOW NEUTRONS IN A FERMI LIQUID.

Akhiezer, I.A.Akhiezer and I.Ya.Pomeranchuk.
eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 478-87 (Aug., 1961).
ussian.

Scattering of slow neutrons in a Fermi liquid is investigated retically. The cross-sections for direct scattering and ttering involving the excitation of zero and usual sound are rmined. [English translation in: Soviet Physics—JETP (USA)].

18324 ELECTRODIFFUSION TREATED AS A RANDOM WALK PROBLEM. T.Thedéen.

Tekn. Högsk. Handl. (Sweden), Vol. 165, 55 pp (1960).

The problem of electrodiffusion combined with ordinary diffusion is studied here as a random walk problem. This analogous problem involves studying a particle which shifts between two states and performs a random walk due to ordinary diffusion and to a superimposed electric field of a periodic (or specially constant) type. The asymptotic normality of the particle position is shown and the related parameters, viz. the mean value and the variance (with corresponding diffusion coefficient) of the particle position, are calculated.

18325 SOME PROPERTIES OF TRANSPORT FLUX AND CURRENT AT THE SURFACE OF GREY PLATES.

A.Jeffrey.
Reactor Sci. (GB), Vol. 12, No. 3, 93-100 (June, 1960).

The spherical harmonics method is applied to an infinite grey slab immersed in a scattering and absorbing medium in which isotropic unit-strength, uniformly-distributed sources are present. Transport flux and current properties are examined at the plate, and extrapolation lengths into the plate are given for a wide range of compositions of plate and surrounding material. The convergence of the odd-order spherical harmonics solution is examined up to an order of thirteen. Finally, diffusion-theory estimates of neutron current based on extrapolation length are compared with the results of P_{13} spherical harmonic calculations and a modified extrapolation length is suggested.

18326 ON THE DIFFUSION MATRIX OF RADIATIVE TRANSFER. S.Ueno.

Ann. Astrophys. (France), Vol. 24, No. 4, 335-41 (1961).

The author previously used the stochastic model of radiative transfer to obtain the diffusion matrix consisting of the reflectance and the transmittance operators in a finite plane-parallel atmosphere of arbitrary stratification. When this method is applied to the distribution of emission sources within the medium, the emergent intensities can be computed without actually solving the equation of transfer. In the present paper, using auxiliary equations in conjunction with the Milne integral equations, the author derives the diffusion matrix along with the extension concerning the Neumann solution as given by Busbridge. In the case of diffuse reflection and transmission of parallel rays, the solutions are expressed in terms of a pair of scattering and transmission functions for each of the two boundaries of the atmosphere. Then these global functions are given by X^* and Y^* functions that are equal to those previously found by Bellman and Kalaba. Whereas the diffusion matrix has a somewhat similar appearance to a map obtained by Preisendorfer, the mathematical development is different. If the optical properties of the medium are constant throughout the atmosphere, the reflectance and transmittance operators obtained here reduce to those given by Sobolev.

THE APPROXIMATE SOLUTION OF THE TRANSFER EQUATION FOR A PLANE GRAY PHOTOSPHERE TAKING ACCOUNT OF THE BLANKETING EFFECT. See Abstr. 18000

18327 THE ENTROPY OF THE DISTRIBUTION OF DYNAMICAL VARIABLES.

A.S.Rubanov and B.I.Stepanov.
Dokl. Akad. Nauk SSSR, Vol. 140, No. 1, 96-9 (Sept. 1, 1961).
In Russian.

The entropy of a distribution of a dynamical variable is defined by analogy of Boltzmann's H-function. This definition is then applied to the distribution of coordinate- and momentum-values of a classical and a quantum-mechanical harmonic oscillator. [English translation in: Soviet Physics—Doklady (USA)]. D.ter Haar

18328 GENERALIZATION OF PLANCK'S LAW SUBJECT TO THE POSSIBLE EXISTENCE OF A THIRD UNIVERSAL CONSTANT. M.Strauss.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 7, 412-17 (1960). In German.

An attempt is made to extend the thermodynamic theory which leads to Wien's theorem to a possible future theory which involves a length as a new universal constant. Planck's radiation law arises in generalized form, but no experimental evidence in its favour is adduced. P.T.Landsberg

18329 RELAXATION PHENOMENA AND THEIR THERMODYNAMIC TREATMENT. J.Meixner.

Ned. Tijdschrift Natuurkde (Netherlands), Vol. 26, No. 9, 259-73 (Sept., 1960). In German.

A semi-popular discussion of relaxation processes with special reference to visco-elastic behaviour and the absorption of sound is given. Instead of a statistical mechanical treatment such as the one given by Kronig (1938) the author uses thermodynamics of irreversible processes. The elastic relaxation in a one-dimensional system is discussed in some detail for the isothermal case, and the relationship with the theory of linear dissipative systems is pointed out. D.ter Haar

GENERAL MECHANICS

18330 LINEARLY SKIRTING CURVES OF CONNECTING RODS IN MECHANISMS WITH A TRANSLATIONAL COUPLE. I.I.Artobolevskii.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 5, 1077-80 (Aug. 11, 1961).
In Russian.

The general theory of these curves, for mechanisms with one translational and with three rotational couples, is presented, leading to parametric equations of the loci. Graphical and analytic steps during construction are given and equivalent systems are discussed. [English translation in: Soviet Physics—Doklady (USA)]. J.K.Skwirzynski

18331 LINEARLY SKIRTING CURVES OF CONNECTING RODS IN AN ELLIPSOGRAPH WITH FOUR LINKS.
I.I.Artobolevskii.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 6, 1336-8 (Aug. 21, 1961).
In Russian.

The parametric equations of loci of moving rods are derived. Two equivalent systems are discussed and conditions for a circular locus are derived. [English translation in: Soviet Physics—Doklady (USA)]. J.K.Skwirzynski

18332 ARALDITE USED FOR MODEL ANALYSIS OF COMPOSITE STRUCTURES. R.S.Alwar.
Brit. J. appl. Phys., Vol. 12, No. 9, 526-7 (Sept., 1961).

Describes successful tests on a model composed of two portions, one made of Araldite and the other of Araldite containing silica flour as filler. The problem under investigation was stress determination in layered systems in dams. J.Thewlis

18333 POST-CRITICAL DEFORMATIONS OF CYLINDRICAL SHELLS UNDER THE ACTION OF EXTERNAL PRESSURE. A.V.Pogorelov.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 6, 1325-7 (June 21, 1961).
In Russian.

For abstract, see Abstr. 15757 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 6, 522-6 (Dec., 1961)].

18334 CONFIRMATION OF THE HERTZ THEORY BY AN INDIRECT METHOD. E.Schürerová.
Czech. J. Phys., Vol. 10, No. 9, 689-90 (1960). In German.

The force due to the impact of a steel sphere on a flat steel plate is measured by an electrical method. The change of electric resistance (in a circuit formed by the sphere on impact) can be augmented by covering the plate with a fine coal dust. The resulting force versus time curves coincide well with the Hertz equation. J.K.Skwirzynski

18335 STUDY OF IMPACT CRATERING IN SAND. F.L.Culp and H.L.Hooper.
J. appl. Phys. (USA), Vol. 32, No. 11, 2480-4 (Nov., 1961).

Investigated for dry sand, using 22-calibre long rifle bullets. Measurements of craters formed by bullets moving at velocities of 50 to 550 m/sec showed the crater volume to vary directly with the square of the bullet velocity at the low end of this range and to approach a linear dependence on bullet velocity at the high end. An equation relating the crater volume to the bullet velocity was developed from a model which assumed hydrodynamic-like flow behind the induced shock wave was found to provide an excellent fit to the experimental data. It was further found that for velocities below 245 m/sec bullet deformation is small, and increases rather slowly with increase in velocity. At 245 m/sec, however, an abrupt transition occurs, and the deformation increases very rapidly. Above
245 m/sec the deformation appears to become constant. This tr
sition velocity is believed to be related to the appropriate veloci
of sound in sand.

18336 THE APPROXIMATE SEPARATION OF KINETICS PROBLEMS INTO TIME AND SPACE FUNCTIONS E
VARIATIONAL PRINCIPLE. J.Lewins.
Reactor Sci. (GB), Vol. 12, No. 3, 108-12 (June, 1960).

The time-dependent adjoint density and a variational princi
are used to find a consistent separated solution approximation f
non-separable problems in reactor kinetics. It is shown that th
"best" average time-independent coefficients are the simple tim
averages and are not to be weighed with the time behaviour of th
flux itself. Solution of the time-independent equations for the fl
shape during this interval enables the "best" value of the logari
derivative of flux to be obtained.

MECHANICAL MEASUREMENTS

18337 MEASUREMENT OF SURFACE MEAN DIAMETER
POWDERS BY HEAT OF IMMERSION METHOD.
S.Okuda, K.Inoue and I.Uei.
Mem. Fac. Industr. Arts Kyoto Tech. Univ. (Sci. Technol.) (Japa
No. 9, 61-77 (1960).

The surface mean diameters of various kinds of powder sa
were estimated by the heats of immersion in water; by compari
the results with those from the other methods it is concluded th
the heat of immersion method devised by Harkins and Jura (194
gives surface mean diameters that are in good agreement with t
from the BET method if nitrogen is chosen as adsorbate. The p
bility of surface area determination by the heat of immersion
method with powder samples that have capillary condensation w
also investigated. Good agreement with the results of the BET
method was obtained.

18338 RECORDING MICRO-DENSITOMETER EMPLOYIN
BETA-RADIATION FROM A CARBON-14 RADIO-
ISOTOPE SOURCE. R.A.Lloyd and E.H.Adams.
Brit. J. appl. Phys., Vol. 12, No. 11, 614-17 (Nov., 1961).

The variation of wood density through the thickness of the
individual growth rings of trees is of interest to those concerne
with forestry research. An experimental instrument was develop
which a finely collimated beam of C^{14} beta-particles is used to
measure the density variations along thin longitudinal sections
with a microtome from radial core borings obtained from the tr
of standing trees. The response of the instrument is linear for
densities up to at least 1.0 g/cm^3 with sections 100 microns thi
and density discontinuities 0.05 mm apart can be resolved. Der
changes of 3.5% can be detected, at a speed of traverse of
0.5 mm/min. The instrument may well be applied to other mat

18339 PRECISE MEASUREMENTS OF THE DENSITY OF MERCURY AT 20°C. II. CONTENT METHOD.
A.H.Cook.
Phil. Trans A (GB), Vol. 254, No. 1038, 125-54 (1961).

For Pt I see Abstr. 531 of 1958. The determinations descr
in this paper are complementary to Pt I in which the density of
mercury was found from the mass of mercury displaced by a so
cube of measured volume (displacement method). In the presen
work (content method) the density was calculated from the mass
mercury filling a hollow cube formed of optically worked blocks
fused silica, the internal dimensions of which could be measure
optical interference. The densities of three samples have been
measured by both methods, the mean difference between method
being 0.45 p.p.m. (part per million).

LIQUID METAL DENSITOMETRY. See Abstr. 18388

18340 SIMPLE ELECTROMANOMETER UTILIZING THE
CdS PHOTOCONDUCTIVE CELL.
T.Azuma, T.Kanno and T.Hirota.
J. sci. Instrum. (GB), Vol. 38, No. 10, 413-14 (Oct., 1961).

The cell, connected to a battery, is placed parallel to and
behind a liquid manometer so that light projected onto the cell

face is partially screened by the liquid column. Changes in ssure are thus converted into changes in photoelectric current. following merits are claimed: (1) the circuit is inexpensive extremely simple, and manometer is easily handled; (2) a eral storage battery can be used as a power supply, thus ninating a.c. noise; (3) the power output is so high that an plifier is unnecessary; (4) it is sufficiently stable to allow the tinuous recording of pressure changes over a long period; the electromanometer can be fitted both for high tension veral hundred mm Hg) and low tension recordings (a few mm) and for a rather wide range of pressure from 1 to 300 mm Hg.
C.F.Barnaby

8341 A PHOTOELECTRIC DEVICE FOR THE TRIP GEAR OF A CHRONOMETER. J.C.Bruyère.
hys. Radium (France), Vol. 21, Suppl. No. 11, 223A-224A ., 1960). In French.

A block diagram showing how the moving beam of an optical r falling on a photoelectric cell can be made to control a onometer release mechanism. A flip—flop eliminates the second se generated when the beam leaves the cell. T.S.E.Thomas

8342 A PRECISION CLOCK FOR MEASURING TIME INTERVALS.
.Findley, R.A.Reiter and T.A.Romanowski.
lear Instrum. and Methods (Internat.), Vol. 9, No. 2, 221-5 , 1960).

A precision electronic clock which uses 10 Mc/s pulses to asure time intervals is described. The linearity and the rage channel width of the system were determined by measuring e intervals between randomly distributed pulses. In these tests ut 250 000 counts per channel were accumulated showing that the tem was linear. The slope of the random distribution of pulses 0002 ± 0.0003 per channel. It was also found, to an accuracy .016%, that the channel width of the time scale was equal to the iod of the 10 Mc/s oscillator. This system is suitable for time rval measurements in a region from 0-15 μsec with an 0.1 μsec olution.

18343 ATOMIC CLOCK ON AN AMMONIA ABSORPTION LINE. K.Matsuura.
earches Electrotech. Lab. (Japan), No. 581, 128 pp. (Dec., 1959). apanese.

The atomic clock is source modulated and uses the J = K = 3 . Constructional details are given including the associated cuits. The physical properties of the ammonia absorption line discussed, including the uncertainties occurring from the wave- de system. Comparison is made with other types of atomic ck which use ammonia absorption.

COMPARISON OF UNIVERSAL TIME (UT2) WITH ATOMIC IE (CsT). See Abstr. 18027

COMPARISON OF TIME DETERMINED BY THE ROTATION OF EARTH WITH TIME OBTAINED FROM ATOMIC EQUENCY STANDARDS. See Abstr. 18022

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

8344 HIGH PRESSURE VESSEL INCORPORATING A TEFLON GASKET FOR USE TO 500°C AND 1000 ATM.
.Gill and W.L.Marshall.
. sci. Instrum. (USA), Vol. 32, No. 9, 1060-2 (Sept., 1961).

A small vessel is described, believed to be leakproof at a perature of 500°C and at hydrodynamic pressures up to 0 atm. Details of the design are given and the use of the vessel he determination of solubilities in aqueous systems is described.
C.F.Barnaby

8345 DETERMINATION OF THE SPECIFIC VOLUME OF LIQUID COPPER—LEAD ALLOYS. T.Malmberg.
nst. Metals (GB), Vol. 89, Pt 4, 137-9 (Dec., 1960).

A method for determining the density of liquid metals, based on the pyknometric principle, was used to make measurements on copper and lead and their binary alloys. The results support the findings of Ekbom concerning the pressure-tightness of cast copper—lead alloys: that in leaded copper alloys the occurrence of the monotectic reaction reduces shrinkage during the later stages of solidification, and thus decreases the amount of microporosity present.

18346 THE MARGINAL STABILITY IN POROUS INHOMOGENEOUS MEDIA. S.I.Gheorghitza.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 4, 871-7 (Oct., 1961).

A theoretical paper which gives a mathematical treatment of breakdown of stability in porous inhomogeneous media of a fluid subject to a vertical temperature gradient. H.G.Jerrard

18347 SIMPLE VISCOMETER FOR USE WITH LOW MELTING POINT METALS. D.M.Cottingham.
Brit. J. appl. Phys., Vol. 12, No. 11, 625-8 (Nov., 1961).

Describes a viscometer suitable for making relative measurements over a wide range of viscosities and over a temperature range of 20° to 600°C. The viscometer is calibrated with standard liquids and was designed particularly for low melting point metals. The operating techniques and sources of error are discussed. An empirical equation relating viscosity to the variable parameters is given and results of experiments on lead are included.

18348 DESIGN AND CALIBRATION OF AN INEXPENSIVE FREE-FLOW ELECTROVISCOMETER.
P.A.D. De Maine and E.R.Russell.
Canad. J. Chem., Vol. 39, No. 10, 1929-33 (Oct., 1961).

Describes the design and calibration of a new inexpensive free-flow electroviscometer for rapid and accurate measurement of the viscosity coefficients for conducting and non-conducting solutions. Flow times of 30 sec are easily reproduced to within 0.02 sec.

18349 METHOD FOR MEASURING DYNAMIC MECHANICAL PROPERTIES OF VISCOELASTIC LIQUIDS AND GELS; THE GELATION OF POLYVINYL CHLORIDE.
M.H.Birnboim and J.D.Ferry.
J. appl. Phys. (USA), Vol. 32, No. 11, 2305-13 (Nov., 1961).

An apparatus was developed to determine the components of the complex shear modulus of viscoelastic liquids and dilute gels over a continuous frequency range from 0.01 to 5 c/s by amplitude-phase shift measurements and from 2.5 to 400 c/s by single-coil transducer-impedance measurements. The temperature range is from −40° to 150°C. The sample is deformed in very small strains with annular pumping geometry, as in the earlier apparatus of Smith, Ferry, and Schremp (Abstr. 1716 of 1949). Preliminary results on 2.29 and 3.00% solutions of polyvinyl chloride in di-2-ethyl hexyl phthalate provide the dynamic storage and loss moduli and the relaxation spectrum as they change during the process of gelation. The moduli of the ungelled solutions, at an early stage of the aggregation process, follow the Zimm theory rather closely, and the local effective viscosity derived thereby lies between the solvent viscosity and the solution viscosity. The loss compliance of the aged gels is approximately represented by the Bueche theory for cross-linked networks. However, it is evident that the gels contain a large proportion of sol fraction (polymer species unattached to the network).

18350 NON-NEWTONIAN VISCOSITY OF POLYMERS. R.S.Porter and J.F.Johnson.
J. appl. Phys. (USA), Vol. 32, No. 11, 2326-31 (Nov., 1961).

The rheology of concentrated and bulk polymer systems was investigated. Studies have been made on a low molecular weight series of several polymers using capillaries and a high shear concentric cylinder viscometer. The compositional and shear conditions for non-Newtonian flow were closely defined. Limiting high and low shear viscosities and the path of non-Newtonian flow may be consistently correlated for concentrated systems of linear, flexible polymers. The minimum molecular weight for non-Newtonian flow is related to the transition at low shear in log (viscosity) versus log (molecular weight) correlations. For non-Newtonian systems, changes in apparent activation heat for viscous flow are reported as a function of shear. The conditions for laminar flow shear degradation of polymers are also given.

18351 THE DYNAMIC BULK AND SHEAR VISCOSITIES OF POLYVINYLCHLORIDE.

R.Kono.

J. Phys. Soc. Japan, Vol. 16, No. 9, 1793-4 (Sept., 1961).

It is shown that the temperature and frequency dependence, the activation energy, and the relaxation times for bulk modulus are similar to those for shear modulus. It is concluded that the molecular mechanism in the volume and shear deformations should be the same. K.Walters

18352 THE PROBLEM OF SPLASH OF WAVES.

R.Gouyon.

C.R. Acad. Sci. (France), Vol. 252, No. 20, 2991-3 (May 15, 1961). In French.

A mathematical solution by an approximation method. T.C.Toye

18353 EQUATIONS FOR THE AVERAGE VALUES OF TEMPERATURES AND CONCENTRATIONS.

E.Ruckenstein.

C.R. Acad. Sci. (France), Vol. 253, No. 10, 1166-8 (Sept. 4, 1961). In French.

In problems which involve the transfer of heat or mass it is important to know the way in which certain average values of the temperature and concentrations depend on a series of parameters. One such problem is the mixing of two fluids through a membrane in an horizontal tube. The equations describing the flow can be transformed into some very simple equations, in which the average values of the quantities being investigated appear. T.E.Peacock

18354 DYNAMIC SIMILARITY OF INSTABILITIES OF DISPLACEMENT FRONTS IN POROUS MEDIA.

A.E.Scheidegger.

Canad. J. Phys., Vol. 39, No. 9, 1253-63 (Sept., 1961).

It has been observed that instabilities may occur when a fluid penetrates into a porous medium which contains another, more viscous fluid. The problem of describing these instabilities analytically is very difficult so that recourse has been taken to model experiments. In the present paper, the scaling relationships (dynamic similarity conditions) for the interpretation of such model experiments are derived, based upon a variety of theories of the instability phenomena.

18355 IMPULSIVE MOTION OF A CIRCULAR CYLINDER IN A VISCOUS FLUID AT SMALL REYNOLDS NUMBERS.

S.Kuwabara.

J. Phys. Soc. Japan, Vol. 16, No. 9, 1762-70 (Sept., 1961).

Calculates the drag of a circular cylinder set in uniform motion impulsively from rest in a viscous fluid. On the assumption of small Reynolds numbers, Oseen's equations for unsteady motion are employed. The two limiting cases corresponding to the initial and final periods, respectively, are investigated.

18356 STABILITY ANALYSIS AND INTEGRATION OF THE VISCOUS EQUATIONS OF MOTION.

L.Fillers and H.F.Ludloff.

Math. Comput. (USA), Vol. 15, 261-74 (July, 1961).

Techniques are established for the numerical solution of the time-dependent, one-dimensional equations of motion of a viscous, heat-conducting fluid. The equations of motion are approximated by suitable finite-difference equations and the stability of the difference equations is investigated by using von Neumann's error analysis. Both explicit and implicit finite difference schemes are studied. The implicit equations are solved by an iteration scheme that is formulated with the condition that its convergence does not place conditions on the mesh width ratio $\Delta t/\Delta x$. S.S.Mitra

18357 PROPAGATION OF SMALL DISTURBANCES IN VISCOUS LIQUID CONTAINED BETWEEN TWO INFINITE CO-AXIAL CYLINDERS.

R.Kumar.

Proc. Nat. Inst. India A, Vol. 27, No. 3, 178-84 (May, 1961).

The propagation of small disturbances produced by giving a circular disk $x^2 + y^2 = a^2$, $z = 0$, a slow angular motion, which can be represented for time $t \geq 0$ by $\omega(t) = \omega_0\delta(t)$ or $\omega_0 e^{ipt}$ in an infinite mass of viscous liquid bounded by the cylinders $x^2 + y^2 = b^2$ and $x^2 + y^2 = a^2$, is studied. It is assumed that forces of the form $X(r)$ are also acting on the liquid. In particular, solutions are obtained when the forces are due to the liquid being self-gravitating or else are of the form (c/r). The sums of three useful and interesting infinite series are also found as corollaries to the main result. The use of Hankel and Laplace transforms is freely made throughout.

18358 HYDRODYNAMIC STABILITY OF A LIQUID LAYE ON A VERTICAL WALL.

V.K.Bushmanov.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1251-7 (Nov., 1961). In Russian.

The flow of a liquid layer on a vertical wall is considered under the influence of gravity. The stability of the plane flow preceding wave flow is investigated in the first approximation. [English translation in: Soviet Physics—JETP (USA), Vol. 12, 873-7 (May, 1961)].

18359 THE QUESTION OF THE HYDRODYNAMIC BEHAVIOUR OF A SIMPLE MACROMOLECULAR MODEL IN AN INHOMOGENEOUS FIELD OF FLOW.

H.Mülle

Z. Phys. (Germany), Vol. 164, No. 2, 139-44 (1961). In Germa

A study of the influence of suspended macromolecules on viscosity of the parent liquid. T.C.

18360 ON A TWO-DIMENSIONAL FREE-BOUNDARY PROBLEM.

R.J.Bean, R.P.Gilbert and H.Kendall.

Z. angew. Math. Phys. (Switzerland), Vol. 11, No. 5, 341-55 (Sept. 25, 1960).

Investigates the determination of the free boundary betwee fluids in a bent channel under dynamic conditions. For a chann with a right-angle bend the possibility of an inflection point in t interface was considered. This situation appeared to correspo an unstable equilibrium; hence when the general problem (a channel with an arbitrary-angle bend) was attempted it was ass that an inflection point could not occur. An ordinary first order differential equation for the free-boundary was obtained, which be solved by a single quadrature.

18361 A FURTHER NOTE ON A TWO-DIMENSIONAL FRE BOUNDARY PROBLEM.

R.P.Gilbert and H.Kenda

Z. angew. Math. Phys. (Switzerland), Vol. 12, No. 1, 69-70 (Jan. 28, 1961).

Contains a numerical illustration to the paper of the preced abstract. It deals with case of a channel with a right-angle ben numerical integration of the differential equation found in the pa It is intended to publish at a later date a more comprehensive solution to this equation.

18362 ON THE WALL EFFECT CORRECTION OF THE STOKES DRAG FORMULA FOR AXIALLY SYMMET BODIES MOVING INSIDE A CYLINDRICAL TUBE.

I.Chang.

Z. angew. Math. Phys. (Switzerland), Vol. 12, No. 1, 6-14 (Jan. 1961).

The motion of a sphere in a vertical tube filled with a stationary fluid was first studied by Ladenburg (1907) who obtai

$$D = 6\pi\mu aU(1 + L\frac{a}{R}),$$

for the drag on a moving sphere whose radius a was much sma than the radius R of the tube; where μ is the viscosity of the flu U the velocity of the sphere, and L a constant approximately eq to 2.104. Under the same conditions the drag on any axially symmetric body moving inside a tube of radius R is:

$$D = D_0(1 + \frac{\kappa D_0}{2\pi^2\mu UR} + 0(a^2/R^2),$$

where D_0 is the Stokes drag for the body moving in an infinite domain of fluid, and κ is a constant approximately equal to 2.20 a is here the radius of the frontal area circle of the body (for hemispherical cup, flat disk of radius a, or sphere of radius a). The cross-section of prolate and oblate spheroids is an ellipse. R.Schnur

18363 ON THE SLOW STEADY MOTION OF AN INFINITE VISCOUS LIQUID DUE TO THE ROTATION OF A CYLINDER WHOSE CROSS-SECTION IS AN OVALOID.

S.R.Khamrui.

Appl. Phys. Quart. (India), Vol. 7, No. 1, 2-4 (1961).

A theoretical analysis of the problem is given. The metho consists in determining two analytical functions from which the velocity components and the couple to be applied to the cylinder maintain the rotation may be found. The theory is used to dedu the results for cylinders whose cross-sections are a circle or ellipse. The latter results agree with earlier work by the auth (Abstr.1130 of 1959). H.G.Je

8364 UNSTEADY FLOW OF A VISCOUS HOMOGENEOUS INCOMPRESSIBLE FLUID IN A CIRCULAR PIPE OF FORM CROSS-SECTION. K.G.Mithal.

. Calcutta Math. Soc. (India), Vol. 52, No. 3, 147-54 (Sept., 1960).
The problem of flow when the pressure gradient is a function of is treated theoretically for Newtonian and non-Newtonian ids. The particular case when the gradient varies exponentially time is presented in detail. The solutions are given in terms essel functions. H.G.Jerrard

8365 FLOW OF A NON-NEWTONIAN FLUID THROUGH AN ANNULUS WITH POROUS WALLS. S.K.Datta.

.Calcutta Math. Soc. (India), Vol. 52, No. 3, 155-62 (Sept., 1960).
The theory is developed for the problem of steady state laminar for fluids which obey the stress–strain relations formulated by ner and Braun (Abstr. 4154 of 1952). An expression is also deed for the velocity of flow for laminar flow between parallel ous plates. H.G.Jerrard

8366 THE NON-UNIFORM ROTATION OF A NON-NEWTONIAN LIQUID FILLED IN BETWEEN TWO XIAL CYLINDERS OF INFINITE LENGTH. K.G.Mithal.

ence Sci. J (India), Vol. 10, No. 3, 228-36 (July, 1960).
Initially, the outer cylinder is rotating with constant angular ocity. When the inner cylinder is at rest, the liquid is supposed e in steady motion but, when it is given an impulsive twist, it begins to rotate with a constant angular velocity and the motion he liquid becomes unsteady. The various states of motion of the id are discussed.

8367 EXTENSION OF THE EYRING—REE THEORY OF NON-NEWTONIAN FLOW [TO POLYMERS]. J.A.Faucher.

ppl. Phys. (USA), Vol. 32, No. 11, 2336-8 (Nov., 1961).
The Eyring—Ree theory (Abstr. 8329-30 of 1955) of nonvtonian flow is extended to the case of a continuous distribution low units. This results in an integral equation of the form

$$F(\dot{s}) = \int_0^\infty G(t) \operatorname{arc\,sinh}(\dot{s}t)dt.$$

s equation can be solved by integral transform methods to d the unknown distribution function G(t) when the flow curve) is known as an analytic function. In the case of limited pirical data, approximation methods can be used to obtain G(t). perimental data are shown for polyethylene at two temperatures the distribution functions calculated.

18368 SIMPLE PROOF OF A THEOREM ON TWO-DIMENSIONAL POTENTIAL FLOW OF INCOMPRESSIBLE UIDS. H.Ertel.

natsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 9, -6 (1960). In German.
The mutual orientation of the isocline and isotach systems in -dimensional flow are described by the theorem that the rotation he isocline gradients to the isotach gradients by the shortest must be by a right rotation by $\pi/2$ when the isoclines are nbered so as to increase by rotating to the right, and vice versa. imple proof of this theorem is given. H.G.Jerrard

18369 NON-STATIONARY STATE OF THE DIRECTION OF MOTION IN A FIELD OF FLOW AS A FUNCTION OF GEOMETRICAL PROPERTIES OF THE STREAMLINES AND JECTORIES. H.Ertel.

atsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 10, -2 (1960). In German.
The velocity vector of a three-dimensional non-stationary field ow is given by $\vec{v} = \vec{T} \cdot v$, in which $\vec{T}$ is a unit vector and v is the olute value of the velocity. The partial differential of T with pect to time t $(\partial\vec{T}/\partial t)$ is a measure of the change of flow direction unit time. An expression for $\partial\vec{T}/\partial t$ at a point in a field of flow erived in terms of the curvatures of the trajectory and streamat that point. The special case of a plane field of flow is also sidered. H.G.Jerrard

8370 ON TWO-DIMENSIONAL BOUNDARY LAYER IN NON-NEWTONIAN FLUIDS WITH CONSTANT FFICIENTS OF VISCOSITY AND CROSS-VISCOSITY. Bhatnagar.

. Indian Acad. Sci. A, Vol. 53, No. 2, 95-7 (Feb., 1961).
The boundary layer approximations are analysed for the twonsional flows of incompressible non-Newtonian fluids with constant coefficient of viscosity μ and constant coefficient of cross-viscosity μ_C. The boundary layer equation reduces to the one for Newtonian liquids with the normal pressure "p" modified to "P", where $P = p - \frac{1}{2}\mu_C(\frac{\partial u}{\partial y})^2$. Due to the cross-viscosity the pressure in the non-Newtonian boundary layer is higher than in the Newtonian fluid of similar viscosity. J.W.Taylor

HEAT TRANSFER FROM LAMINAR FLOW THROUGH CYLINDRICAL TUBES. See Abstr. 18651

18371 THE MECHANISM OF TURBULENT MASS TRANSFER NEAR A FLUID INTERFACE. E.Ruckenstein.

C.R. Acad. Sci. (France), Vol. 252, No. 20, 3036-8 (May 15, 1961). In French.

Turbulent flow of a fluid in the neighbourhood of a liquid film is considered. By the way of dimensional and other semiquantitative arguments relations are established by which the mass-transfer coefficient is connected with parameters specifying the flow, such as the shearing stress at the interface. R.Eisenschitz

18372 ON THE TURBULENT FLOW OF FLUIDS. J.Gosse.

C.R. Acad. Sci. (France), Vol. 253, No. 1, 61-3 (July 3, 1961). In French.

A discussion of the variation of eddy viscosity. T.C.Toye

18373 A FAMILY OF EXACT SOLUTIONS OF ONE-DIMENSIONAL ANISENTROPIC FLOW. D.G.Weir.

Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 4, 890-4 (Oct., 1961).

A theoretical paper. If the pressure and the Lagrange variable are taken as independent variables, then problems in one-dimensional unsteady flow of an ideal gas reduce to the problem of finding solutions of the Monge—Ampère equation, but when isobars and trajectories coincide the method is not applicable. The author investigates a method which can be used for this latter case and gives solutions. H.G.Jerrard

THERMODYNAMICS OF TURBULENT SYSTEMS. See Abstr. 18680

RADIATION OF SOUND IN A LIQUID WITH CAVITATION PRESENT. See Abstr. 18509

18374 TRANSITION RANGES FOR THREE-DIMENSIONAL WAKES. R.H.Magarvey and R.L.Bishop.

Canad. J. Phys., Vol. 39, No. 10, 1418-22 (Oct., 1961).

The motions set up in a liquid due to the passage of a drop of an immiscible liquid were examined for a number of liquid—liquid systems. Wake configurations corresponding to Reynolds numbers between 0 and 2500 were photographed, and the transition ranges between the various wake configurations were determined. Several liquid—liquid systems were used in obtaining data on wake patterns, and it was found that identical patterns correspond to approximately the same Reynolds numbers regardless of the system. However, the exact transition number cannot be determined for the general case as drop deformations depend on the physical characteristics of a particular system. The range of Reynolds numbers corresponding to a transition from one wake pattern to another is somewhat less than 20.

18375 ANALYSIS OF THE FLOW AND ENERGY SEPARATION IN A TURBULENT VORTEX.

R.G.Deissler and M.Perlmutter.

Internat. J. Heat Mass Transfer (GB), Vol. 1, No. 2-3, 173-91 (Aug., 1960).

An analysis is made of the velocity, temperature and pressure distributions in a turbulent vortex with radial and axial flow. For making the calculations the vortex is divided into a core and an annular region, each with a different uniform axial mass velocity, although the equations obtained are applicable to an arbitrary axial mass velocity distribution. Tangential velocity, temperature and pressure distributions, as well as curves for overall energy or temperature separation, are presented and compared with experiment. Using the analytical results, the causes of the energy separation are studied. It is concluded that the most important factor affecting the total temperature of a fluid element in a compressible vortex is the turbulent shear work done on or by the element.

18376 INSTABILITY OF THE FLOW BETWEEN TWO ROTATING CYLINDERS, COMPARED WITH THE TAYLOR-ROTATION FOR SELECTED GAP-DISTANCES.

K.Kirchgässner.

Z. angew. Math. Phys. (Switzerland), Vol. 12, No. 1, 14-29 (Jan. 25, 1961).

Investigated for any gap-distance. Previous work on this problem, viz. the Taylor theory, was restricted to small gaps. In contrast to the recent analysis of Chandrasekhar (Abstr. 5683 of 1958), the method is independent of the basic flow and is valid for all flows between two coaxial cylinders and may in fact be used for the analysis of the flow in a curved channel. The major physical quantity is the critical Reynolds number, i.e. the value of the Reynolds number at which small disturbances are first amplified. It is determined by the smallest positive eigenvalue of the boundary value problem. An existence proof is presented for this eigenvalue for any wavenumber and for all possible cases of cylindrical flow, with the exception of that in which the cylinders rotate in opposite directions. The results are depicted in a convenient form, the critical Reynolds number being the dependent variable and the gap-distanc distance and angular velocity ratio of the two cylinders the independent variables, respectively. A comparison with experiment is made for the case in which the ratio of the two radii is 2 : 1, and the outer cylinder is at rest. The agreement with theory is good, the observed error being approximately 1%.

18377 TWO-DIMENSIONAL SUPERSONIC JET OF A CONDUCTING INVISCID GAS IN THE PRESENCE OF A UNIFORM MAGNETIC FIELD.

S.Morioka.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1625-30 (Aug., 1961).

The behaviour of the two-dimensional supersonic jet of an ideal gas with weak electric conductivity in the presence of a uniform magnetic field is considered on the basis of the linearized theory. In general, the boundary of the jet can be expressed by the formula which contains the terms giving the monotonic change of the width of the jet and its deflection due to the inclination of the lines of force, in addition to the term in the ordinary gasdynamics. The expressions for these terms are shown explicitly.

18378 THE EFFECT OF DENSITY DIFFERENCES ON THE PATH OF JETS.

C.H.Bosanquet, G.Horn and M.W.Thring.

Proc. Roy. Soc. A (GB), Vol. 263, 340-52 (Sept. 19, 1961).

A turbulent jet of fluid injected into surroundings of different density, soon diverges from its axis of projection as a result of gravitational or buoyancy forces. This feature is exhibited by hot gas jets, in particular by flames, preheated secondary air jets, and effluent plumes. In this paper a water-model technique is described which has been devised to represent the path taken by such jets. This consists of a large transparent box through which a slow stream of water flows and into which a jet of magnetite slurry is injected, to be photographed against an illuminated background. In the model the jet density is greater than that of the surroundings, but the results apply equally to the case where the density ratio is reversed, by considering the trajectory to be inverted. A method of predicting the axes of the heterogeneous jet systems in terms of the initial velocity, the density ratio, the nozzle diameter and the angle of inclination of the axis of projection, is presented. Predicted axes for a variety of operating conditions are shown to compare favourably with observed values obtained in the water model.

18379 ERRATUM: I. EXPANSION AND CONTRACTION OF CAPILLARY JETS OF NEWTONIAN LIQUIDS; II. EXPANSION AND CONTRACTION OF CAPILLARY JETS OF VISCOELASTIC LIQUIDS.

S.Middleman and J.Gavis.

Phys. of Fluids (USA), Vol. 4, No. 11, 1450 (Nov., 1961).

See Abstr. 11743 of 1961.

18380 THE EFFECT OF AN EXPLOSION IN A COMPRESSIBLE FLUID UNDER GRAVITY.

R.A.Ross.

Canad. J. Phys., Vol. 39, No. 9, 1330-46 (Sept., 1961).

An investigation is made of the effect of an axially symmetric explosion at any depth in a semi-infinite, compressible, non-viscous fluid, acted upon by gravity. The explosion is represented by a line source of the form $\delta(x)\delta(z-h)\delta(t)$, where h is the depth of the source. An exact solution is given using the linearized theory. This solution is studied in detail by asymptotic methods, for the special case of a surface explosion. It is found that compressibility results in the gravity waves being propagated with a speed less than c, the speed of sound in the fluid. If x is the distance from the explosion and t the time that has elapsed after the explosion, then for
$4^{1/3}/3 < x/ct < 1$ only "precursor" waves are noticed at the point
observation. For $x/ct < 4^{1/3}/3$ large-amplitude waves are prese
similar to the waves predicted by the incompressible theory.

18381 HEIGHT OF WAVES IN HYDRAULIC MODELS BY T METHOD OF STEREOSCOPY.

J.W.Railly and B.F.Scott.

J. sci. Instrum. (GB), Vol. 38, No. 11, 442-4 (Nov., 1961).

The analogy between the flow of shallow water over a horiz
plane and the two-dimensional unsteady flow of a compressible
is well known, and an interpretation of the behaviour of the hydr
model, and hence of the gas, requires, at any instant of time, th
distribution of water depth over a horizontal plane. Because th
flow may often be of a time-dependent type, a photographic met
has obvious advantages, and the only one which appears suitable
the method of stereoscopy. In this application three lenses are
and the glass table over which the water flows is lit from below
well-diffused light from electronic flash. The water surface is
marked by the use of floating markers obtained by the introduct
of teleprinter "confetti", a by-product of the punching of paper
The optimization of the optical system and the method of obtain
the height of any of the floating markers, and, hence, of the wat
surface, is described: with a moderate outlay water depths can
measured to 0.005 in.

18382 FLOW PROBES. I. PITOT TUBES.

W.Wuest.

Arch. tech Messen (Germany), No. 299, (Ref. V 116-9), 245-8 (Dec., 1960). In German.

An analysis of the behaviour of Pitot tubes and a discussio
the errors involved in their use. There is an extensive bibliog
and other work on the subject is discussed. T.C

18383 MICROMANOMETER AND PITOT TUBE INTENDE FOR THE EXPLORATION OF THE VELOCITY PROFILE IN A FLOW OF WATER WITH NATURAL CONVECTI BETWEEN TWO VERTICAL PARALLEL PLATES.

L.Santon and P.Vernier.

C.R. Acad. Sci. (France), Vol. 253, No. 5, 780-2 (July 31, 1961) In French.

For plates 5 to 12 mm apart the velocities and manometric
heights are less than 10 cm/sec and 0.5 mm of water, respectiv
An optical arrangement similar to that of Fortier (1934) was us
for observation of the meniscus of the tube of the manometer.
the static and total pressures were observed simultaneously. T
Pitot tube was calibrated at the two positions between the plates
the calibration curve of the Pitot coefficient as a function of
Reynolds number (0 to 80) is given. S.Weint

18384 SURFACE TENSION OF ELECTROLYTIC SOLUTIO

C.Sălceanu.

C.R. Acad. Sci. (France), Vol. 253, No. 5, 862-3 (July 31, 1961) In French.

The author's falling-drop method (1939) is used for the dir
determination of the surface tensions of solutions of NaCl, KCl,
NH$_4$Cl, NaNO$_3$, KNO$_3$ and KI. The data indicate that the nature
electrolytic ion is responsible for the increase in surface tensi
the water. H.H.Ho

18385 CALCULATION OF METAL SURFACE TENSIONS. IONIC-SALT AND MONATOMIC MODELS FOR LIQ METALS.

S.W.Mayer.

J. chem. Phys. (USA), Vol. 35, No. 4, 1513-14 (Oct., 1961).

Good agreement with observed values is found for surface
tensions calculated using an ionic-salt model for the alkali met
alkaline earth metals and metals of groups IV and V, and a
monatomic model for metals near the centres of the series of t
periodic table. W.J.Orville-Th

18386 THE SURFACE TENSIONS OF LIQUID METALS AT THEIR MELTING POINTS.

S.W.Strauss.

Nuclear Sci. Engng (USA), Vol. 8, No. 4, 362-3 (Oct., 1960).

The interdependence of surface tension and energy of vaporiz
per unit volume is established for over forty liquid metals at t
melting points; a linear log:log relationship exists between surf
tensions and energy of vaporization. Deviations are shown by M
Zn, Cd and Hg, all of which have small liquid ranges. J.W.T

18387 NOTE ON THE EÖTVÖS CONSTANT.
J.F.Joliet and M.Bernard.
. Acad. Sci. (France), Vol. 253, No. 11, 1205-6 (Sept. 11, 1961).
rench.

The Eötvös constant (K) appears to depend on the dimensions of the ecule. In the case of linear chain hydrocarbon molecules I_{2n-1}K, this constant has a value very close to $0.34n^{2/3}$, that is, ncreases indefinitely with n. T.E.Peacock

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

18388 THE DENSITY OF LIQUID LEAD AND OF DILUTE SOLUTIONS OF NICKEL IN LEAD.
.Strauss, L.E.Richards and B.F.Brown.
lear Sci. Engng (USA), Vol. 7, No. 5, 442-7 (May, 1960).

The densities of liquid lead and of liquid nickel-lead solutions taining up to about 3.5 atomic per cent nickel were measured as nction of temperature using a modified Archimedean method. as found that the densities of the nickel-lead solutions were ater than that of pure liquid lead and increased with increase in el content. Partial molal volumes for nickel and lead were determined by the method of intercepts. The results indicate for the composition regions investigated the partial molal ume of lead does not differ significantly from the molal volume ead and the partial molal volume of nickel approaches a value of o at high dilution.

8389 THE STRUCTURE OF LIQUID MERCURY.
G.Voigtlaender-Tetzner.
rwissenschaften (Germany), Vol. 48, No. 15, 520-1 (1961).
erman.

The author claims that an "exact structure analysis" of ids and amorphous solids is made possible by recent work. id mercury is studied as a test-case. A diagram of the struc- assumed is given, and the numbers of atoms in the different ls, obtained from the X-ray scattering, are found to agree ely with it. It is concluded that the structure closely resembles storted crystal lattice, all "perfect crystal" and "interstitial" ances being present. The nearest shell is found to contain t ten atoms, as compared with twelve for the crystal and eleven the assumed structure. H.N.V.Temperley

SYMMETRY OF MOLECULES, MELTING OF CRYSTALS, AND ERING OF LIQUIDS. See Abstr. 18679

ELECTRONIC BAND STRUCTURE IN LIQUID METALS. Abstr. 17443

18390 AN ACOUSTIC CONTINUUM MODEL OF MOLECULAR FRICTION IN SIMPLE DENSE FLUIDS. S.A.Rice.
ecular Phys. (GB), Vol. 4, No. 4, 305-10 (July, 1961).

An acoustic model is presented with the aim of calculating an r bound for the molecular friction constant. Problems arising n the use of macroscopic boundary conditions at molecular aces are circumvented by treating the molecule in a continuum distributed force centre modifying the propagation of acoustic es. The computed friction constant is a factor of two larger experiment. Physical arguments are given for the validity e relation $\zeta_0 < \zeta$ (real system) $< \zeta$ (acoustic) with ζ_0 and ζ ned by given equations. Other acoustic models are briefly ussed.

8391 ON THE KINETIC THEORY OF DENSE FLUIDS. VIII. SOME COMMENTS ON THE FORMAL
IPUTATION OF THE NON-EQUILIBRIUM DISTRIBUTION
CTION OF A FLUID. S.A.Rice, J.G.Kirkwood and R.A.Harris.
sica (Netherlands), Vol. 27, No. 8, 717-32 (Aug., 1961).

Two problems are considered: (a) the formal cluster expansion e integro-differential equation determining the non-equilibrium dy distribution function, and (b) methods of computing the e-space transformation function. Two formal solutions for the e-space transformation function are presented, one exact for case of weak interactions, and one approximate and connected ely with the concepts of local equilibrium and Brownian motion. The cluster expansion leads to collision kernels corresponding to multiple body encounters. The operators are so defined that at least one interaction must occur between a group of m molecules and a separate group of n molecules for there to be a non-vanishing contribution to the transport equation for the m-th order distribution function. Interactions wholly within the group m or the group n make no contribution. To mitigate the difficulties in computing multiple body trajectories it is suggested that the approximate solutions for the transformation functions be used in the theory of dense fluids.

18392 THE STRUCTURAL MODEL OF MONATOMIC LIQUIDS INCLUDING METALLIC LIQUIDS NEAR THE MELTING POINTS. K.Furukawa.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 4, 368-83 (Aug., 1960).

Under criticism of the data of atomic radial distribution curves for monatomic liquids, a simple reduced-type structural model of liquids near their melting points having only one parameter is proposed, which is the value of the molecular diameter approximated by a quasi-rigid sphere, and is inter-related with the r.m.s. amplitude of molecular vibration. It is, therefore a function of temperature. Combining this model with the free volume theory, several molecular properties of monatomic van der Waals and metallic liquids including spherico-symmetrical molecular liquids are unitarily explained; for example, at their melting points, the shapes and positions of 1st and 2nd peaks in the radial distribution curves, the molar volumes, the self-diffusion coefficients, the viscosity coefficients and the entropies etc. It is also useful to interpret the apparent differences of properties between van der Waals and metallic liquids. The model suggests that the existence of the critical point between the solid and liquid (or fluid) may be possible.

18393 THE THEORY OF THE LIQUID STATE.
M.Siol.
Z. Phys. (Germany), Vol. 164, No. 1, 93-110 (1961). In German.

The phenomenon of melting is considered as an order—disorder change. On the basis of activation energy for atom movement among nearest neighbours in the liquid state, values are calculated for the melting point, the entropy of fusion, and the volume change on melting. A viscosity formula is also obtained which is similar to that due to Andrade for viscosity at the melting point. T.C.Toye

18394 ON THE PARTIAL THERMODYNAMIC FUNCTIONS.
A.Krupkowski.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 4, 199-207 (1960).

An elementary discussion of a new parameter (the "partial substitute pressure") which could be used to describe the thermodynamic properties of solutions. It is Φ_i, as defined by

$$\mu_i(p,T,x) = \mu_{io}(p_o,T) + RT\ln\Phi_i(p,T,x)$$

where μ_i is the chemical potential of the i-th species in solution; μ_{io} refers to "pure i"; p_o is the standard pressure. R.O.Davies

18395 HEAT CAPACITY C_V OF WATER AND WATER VAPOUR AT HIGH TEMPERATURES AND HIGH PRESSURES. Kh.I.Amirkhanov and A.M.Kerimov.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 2, 398-401 (July 11, 1961). In Russian.

See previous paper in Dokl. Akad. Nauk SSSR, Vol. 113, No. 2 (1957). All measurements were carried out by the same method as before, but with a continuous and vigorous stirring of both the liquid in the calorimeter and the thermostatic liquid. The temperatures applied varied from 50 to 500°C, and the pressures were up to 800 atm. It was found that calculated data for the two-phase region above 300°C, and their derivatives markedly deviate from the experimental data; in the single-phase region adjacent to the boundary curve it is quite out of the question to determine c_V by calculation. [English translation in: Soviet Physics—Doklady (USA)]. F.Lachman

18396 THE THERMAL CONDUCTIVITY OF HEAVY WATER BETWEEN 75° AND 260°C AT PRESSURES UP TO 300 ATM. H.Ziebland and J.T.A.Burton.
Internat. J. Heat Mass Transfer (GB), Vol. 1, No. 2-3, 242-54 (Aug., 1960).

The thermal conductivity of heavy water having an isotopic purity of 99·85% was measured with a vertical coaxial cylinder apparatus at pressures between 24 and 294 atm in the temperature range 75° to 260°C. The pressure range of the experiments included the critical pressure (218 atm). Identical with the trend exhibited by water, the thermal conductivity of heavy water was found to increase with rising temperature to a shallow maximum near 110°C and to fall with a further rise in temperature. The influence of pressure on thermal conductivity was small, and at 75°C amounted to an increase of 0·77% for a pressure rise from 1 to 100 atm. This is similar to the values reported for natural water by Timrot and Vargaftik (1940) and Lawson, Lowell and Jain (1959). In comparison with natural water, the thermal conductivity of heavy water, in the range investigated, was always lower. According to these tests the ratio k_{H_2O}/k_{D_2O} increased almost linearly from 1·045 at 75°C to a value of 1·134 at 260°C. No measurements of the thermal conductivity of heavy water have previously been reported at temperatures above 82°C. Below this temperature the present data are in good agreement with earlier work.

18397 QUANTUM MECHANICAL CALCULATION OF PROTON AFFINITY.

N.A.Izmailov, Yu.A.Kruglyak, R.Gashpar [Gáspár] and I.Tamassi-Lentei [Tamássy-Lentei].

Acta phys. Hungar., Vol. 13, No. 2, 203-10 (1961). In Russian.

Some deficiencies of the electrostatical theory of the formation of solvates can be eliminated by supposing a more general mechanism of the solvation of ions, the solvation being considered as the formation of complexes. This hypothesis includes, as a special case, the electrostatical conception. The mechanism of solvation of the proton and the value of its energy of solvation are different from those of the other ions. Computations based on quantum theory are effected in order to determine the proton affinity of the water molecule and of some ions since these data are of great importance for the theory of acid-basis interactions, and in estimating the acidity of solutions. On the basis of the united atom model the energies of the systems HF, F^-, HO^-, O^{--}, HO^-, H_2O and H_3O^+ are determined, as well as the proton affinities of the ions F^-, O^{--}, O^-, HO^- and of the molecule H_2O, and also the heat of formation of the water molecule from the ions HO^- and H_3O^+. The computed values show good agreement with those obtained experimentally.

18398 THE DISTANCE OF APPROACH OF IONS IN WATER SOLUTION FROM THE NUCLEAR MAGNETIC RESONANCE LINE WIDTHS. H.G.Hertz.

Z. Electrochem. (Germany), Vol. 65, No. 1, 20-36 (1961). In German.

Measurements are reported of the nuclear magnetic resonance line widths of Br^{79} and I^{127} nuclei in ions in water solution. The concentration dependence is measured for cases in which the ions are completely dissociated including the bromides and iodides of Li, Na, K, Rb, Cs, Mg, Ca, Sr, and Ba. Formulae are developed to describe the line width over the whole range of concentration. A comparison with experiment permits an estimate of the effective separation of anion and cation in the solution. See also following abstract. J.G.Powles

18399 EXCHANGE RATE OF IONS CONTAINING BROMINE AND IODINE IN WATER SOLUTION FROM THE NUCLEAR MAGNETIC RESONANCE LINE WIDTHS. H.G.Hertz.

Z. Electrochem. (Germany), Vol. 65, No. 1, 36-50 (1961). In German.

The rate constants for exchange reactions of the type $MeX_{i-1} + X^- \rightleftharpoons MeX_i^-$, where Me is a metal and X is bromine or iodine were determined for water solution from the Br^{81}, Br^{79} and I^{127} nuclear magnetic resonance line widths for the substances $CdBr_2$, $HgBr_2$, $ZnBr_2$, CdI_2 and ZnI_2. See also preceding abstract. J.G.Powles

18400 THE SWELLING OF UNFILLED AND HIGHLY FILLED POLYMERS. K.W.Bills, Jr and F.S.Salcedo.

J. appl. Phys. (USA), Vol. 32, No. 11, 2364-7 (Nov., 1961).

The swelling of elastomers in solvents is a useful method for determining the effective crosslinking of the polymeric structure. It is shown that this method may be applied satisfactorily to highly filled polymers. A unique method was devised for accurate measurement of the swelling ratio of the gel phase of the filled polymers, based on the observation that the binder-filler bond, for most filler particles, releases on swelling. The binder around the particle swells, leaving a hollow pocket which becomes filled with solvent. Corrections for this "waste" solvent lead to the equa from which the swelling of the polymer can be calculated. Ex mental verification is given for several filled systems.

18401 INFLUENCE OF DENSITY FLUCTUATIONS ON ULTRASONIC WAVES IN A BINARY LIQUID MIXT NEAR ITS CRITICAL SOLUTION POINT. A.Śliwiński.

Acta phys. Polon. (Poland), Vol. 20, No. 3, 267-8 (1961).

18402 ULTRASONIC VELOCITY IN LIQUID BINARY MIXTURES. M.V.Kaulgud.

Acustica (Internat.), Vol. 10, No. 5-6, 316-22 (1960).

The formulae of Eyring et al. (1937) and of Kittel (1946) fo sound velocity in normal liquids cannot be applied to binary mixtures for want of a reliable method for calculating the free volume and the available volume. The empirical formula of Jacobson [Acta Chemica Scandinavica (Denmark), Vol. 6, 1485 (1952)] viz. $U L_f \rho^{1/2} = K$ can be used for this purpose since the definition of the free length L_f in the case of pure liquids can b extended to binary mixtures. By substituting the ideal value of

$$\frac{1}{\rho_{mix}} = \left(\frac{w_1}{\rho_1} + \frac{w_2}{\rho_2}\right)$$

in the free length formula for binary mixtures

$$L_{mix} = 2\,\frac{\dfrac{1}{\rho_{mix}} - \left(\dfrac{w_1 V_{0_1}}{M_1} + \dfrac{w_2 V_{0_2}}{M_2}\right)}{\left(\dfrac{w_1 Y_1}{M_1} + \dfrac{w_2 Y_2}{M_2}\right)}$$

the values of both $L_{mix,\ exptl}$ and $L_{mix,\ ideal}$ can be calculate The calculations in the case of ten binary systems reveal that deviation from additivity of u.s. velocity depends upon whether $L_{mix,\ exptl}$ is greater or less than $L_{mix,\ ideal}$.

18403 STUDY OF ULTRASONIC VELOCITY IN LIQUIDS. P.R.K.L.Padmini and B.Ramachandra Rao.

Indian J. Phys., Vol. 35, No. 7, 346-53 (July, 1961).

Ultrasonic velocity measurements were carried out in a n of organic liquids, low-melting-point organic solids in the molte state and corrosive inorganic liquids. The important constants adiabatic compressibility, β_{ad}, γ, C_v, Van der Waals' "b" and molecular radii are computed. A method different from that o Schaaff (Abstr. 100 of 1952) was followed in computing the valu "b" for atoms and linkages and values for some atoms and link are obtained. It is found that the contribution of the semipolar to Van der Waals' "b" is negative.

18404 INFLUENCE OF THE DIELECTRIC CONSTANT O ULTRASONIC RELAXATION FREQUENCY IN MnS SOLUTIONS. S.K.Kor and G.S.Verma.

J. chem. Phys. (USA), Vol. 35, No. 4, 1512-13 (Oct., 1961).

Studies of the effect of dielectric constant on the relaxatio frequency in $MnSO_4$ solution show that the relaxation frequency decreases with the lowering of the dielectric constant. W.J.Orville-T

18405 ULTRASONIC DISPERSION IN ACETONE. C.R.Rao.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1636-8 (Aug., 1961).

The study of dispersion of acoustic velocity in acetone employing ultrasonic waves of very high frequencies up to 180 Mc/s was made for the first time and no positive evidence dispersion could be established. It is shown that the angular d bution of high frequency diffraction is less in acetone than that water, as this depends only on the parameter $\pi L/\lambda^*$ where L corresponds to the length of the sound path traversed by the li beam and λ^* corresponds to the sound wavelength in the mediu

18406 STUDY OF TEMPERATURE VARIATION OF ULT SONIC VELOCITY AND ADIABATIC COMPRESSIB IN SOME LIQUIDS. I. P.R.K.L.Padmini and B.Ramachandra

J. Phys. Soc. Japan, Vol. 16, No. 9, 1770-6 (Sept., 1961).

Temperature variation of u.s. velocity and density was st in some organic liquids, low melting point organic solids in th melt state, and corrosive inorganic liquids. It was found that the cases the u.s. velocity decreased linearly with increase of temperature. The temperature independence of Rao's molar

:ity (1940) was studied for the first time in corrosive inorganic
ds. The new relations put forward by Kishimoto and Nomoto
tr. 4237 of 1954) for temperature coefficients of velocity,
ity and adiabatic compressibility in terms of boiling point were
nined and confirmed. The relation put forward by Lagemann:
$\times (\Delta V/\Delta T)$(Abstr. 3047 of 1949) was also examined.

407 ULTRASONIC VELOCITY IN AQUEOUS SILVER NITRATE SOLUTION. D.S.Allam and W.H.Lee.

re (GB), Vol. 191, 1388-9 (Sept. 30, 1961).
A minimum velocity at a concentration of about 4 M has been
vered in experimental studies of the variation of 263.3 kc/s
sonic velocity with concentration in aqueous silver nitrate
ion at 25° C; no similar minimum occurs with ammonium
te. It is pointed out that the sign of the variation depends on
elative variations with concentration of density and
atic compressibility. L.Mackinnon

408 TEMPERATURE COEFFICIENT OF ULTRASONIC VELOCITY IN LIQUIDS WITH CARBOXYL GROUP THYL-FORMATE). C.Ener and N.Ş.Taşköprülü.

Fac. Sci. Univ. Istanbul C (Turkey), Vol. 25, No. 3-4, 91-3
-Oct., 1960).
Ultrasonic velocities in methyl formate were measured at
rent temperatures by the method of double-cell optical
action. The temperature coefficient of sound velocity is
t = -4.6 $\mathrm{msec}^{-1}\,\mathrm{deg}^{-1}$. Adiabatic compressibility
7 $\times 10^{-12}$ $\mathrm{cm}^2\,\mathrm{dyne}^{-1}$ at 20° C.

8409 PHASE VELOCITY OF ULTRASOUND IN THE PRIMARY ALIPHATIC AMINES. L.V.Kite.

re (GB), Vol. 190, 1183 (June 24, 1961).
This is determined using a continuous-wave frequency-
lated ultrasound (frequency 10.7 Mc/s ± 40 kc/s) transmitted
igh a double crystal interferometer. The method shows an
oved sensitivity over others permitting the use of lower sound
sities or transmission through liquids of higher absorption.
:ity measurements in the homologous series of primary
atic amines to an accuracy of about ±0.23% are reported. The
ge in the molecular velocity with the addition of successive
₂— groups agrees well with other published work.
H.D.Parbrook

3410 REFRACTIVE INDEX DIFFERENCE OF DILUTE AQUEOUS SOLUTION OF POLYVINYLPYROLIDON.

iyake and J.Furuichi.
hys. Soc. Japan, Vol. 16, No. 6, 1263-4 (June, 1961).
Very dilute solutions of high polymers in water show anomalies
scosity. Alternative theories have been put forward to explain
changes. The refractive index measurements quoted tend to
irm that the anomaly arises from the interaction of the
oxylgroup with the structure of the water. R.W.Fish

8411 THE CONNECTION OF THE ABSORPTION AND FLUORESCENCE SPECTRA OF SOLUTIONS.

.skeméty, J.Dombi and.R.Horvai.
phys. Hungar., Vol. 12, No. 3, 263-7 (1960).
This preliminary report gives a generalization of Stepanov's
ession (Abstr. 8517 of 1957) for the quantum yield function
$/\epsilon(\nu)$, where $f_e(\nu)$ is the emission, $\epsilon(\nu)$ the absorption energy
unit frequency range, of the solution. Experimental results for
ral solutions are given, which agree remarkably well with the
ors' expression involving the equilibrium distribution function
he "absolute temperature of the fluorescent molecules".
F.Ansbacher

3412 INFRARED SPECTRA OF CARBONIC ANHYDRIDE UNDER PRESSURE IN SOLUTION IN ORGANIC VENTS. J.Jacob.

Acad. Sci. (France), Vol. 253, No. 3, 425-7 (July 17, 1961).
rench.
The spectra of CO_2 dissolved under pressure in CCl_4 and
was studied in the range 5600 to 610 cm^{-1} using a fairly
le apparatus. Differences observed between the spectrum in
ion and in the gaseous state are discussed. G.I.W.Llewelyn

413 COMPARISON OF THE INFRARED SPECTRA OF THE MOLECULES H_2S AND HDS IN SOLUTION.

umagne, J.Lascombe and J.Devaure.
C.R. Acad. Sci. (France), Vol. 253, No. 4, 632-4 (July 24, 1961).
In French.

Spectra of mixtures of various proportions of D_2S and HDS in organic solvents were obtained, and compared with that of H_2S; as a result, the H_2S band near 2600 cm^{-1} is attributed mainly to the symmetrical vibration ν_1, with a shoulder at 2610 cm^{-1} (in CCl_4 solution) due to the antisymmetrical vibration ν_3.
J.Hawgood

18414 ISOTOPIC STRUCTURE OF THE RAMAN LINE OF LIQUID CHLORINE AND SOLVENT EFFECT OF CHLORINE ON ARSENIC CHLORIDE.

M.L.Delwaulle and F.Wallart.
J. Phys. Radium (France), Vol. 22, No. 5, 327-8 (May, 1961).
In French.

The fine structure of the Raman spectrum of a mixture of $AsCl_3$ and liquid Cl_2 is briefly reported, and compared with the Raman spectra of the respective components. G.I.W.Llewelyn

18415 OBSERVATIONS OF LIGHT EMITTED UPON DISSOLUTION IN LUMINESCENT LIQUIDS OF IRRADIATED NaCl, LiF, KI AND SOME ORGANIC SOLIDS.

T.Westermark and B.Grapengiesser.
Ark. Kemi (Sweden), Vol. 17, Paper 11, 139-49 (1961).

Using a photomultiplier arrangement, light flashes can be detected when irradiated solids are dissolved in liquids. For instance, solutes which are both fluorescent and surface active become electronically excited and give strong fluorescence (e.g. PPO in water-dioxane, Belloid TD in water) upon addition of irradiated NaCl. Aqueous Tl-salt solutions also give strong fluorescence with irradiated NaCl. The light emitted by these three systems can easily be seen by the naked eye. The results for NaCl are calibrated with tritium beta-rays and tentatively interpreted in terms of stored energy. Hygroscopic substances like KI and some organic solids lose this irradiation effect after storage in air of high humidity. The treatment of polystyrene sheets with radiation and electrical discharges gives qualitatively the same effects.

18416 THE SPHERE OF INFLUENCE FOR QUENCHING IN THE CASE OF ENERGY TRANSFER IN TRIPLET LEVELS. V.L.Ermolaev.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 2, 348-51 (July 11, 1961).
In Russian.

The variation of the quenching of donor luminescence by the addition of an acceptor substance was measured either in continuous excitation by monochromatic 3650A or 3340A radiation or by a double-disk phosphoroscope method. The measurements were made for numerous organic materials in solution as a function of added acceptor concentration and the sphere of influence calculated. In addition the quantum efficiency of sensitized phosphorescence in these solutions is tabulated. [English translation in: Soviet Physics-Doklady (USA)]. K.N.R.Taylor

18417 WING OF THE RAYLEIGH LINE RECORDED WITH A SELF-RECORDING GRATING SPECTROPHOTOMETER. S.C.Sirkar, S.B.Roy and D.K.Ghosh.

Indian J. Phys., Vol. 35, No. 8, 377-85 (Aug., 1961).

A self-recording spectrophotometer was constructed using a Bausch and Lomb plane grating, with Ebert mounting, a thirteen-dynode photomultiplier, a d.c. amplifier and a Honeywell—Brown pen recorder. The resolution is found to be much higher than that given by the commercial recording spectrophotometers in which prisms are ysed as the dispersing system. The wing of Rayleigh line due to benzene at different temperatures and that due to liquid oxygen were studied with this instrument. Benzene at 5° C shows two broad maxima in the wing which disappear when the liquid is heated to 75° C. Liquid oxygen shows a feeble wing with inflections about 38, 49 and 60 cm^{-1} away from the Rayleigh line. These results are discussed.

18418 INFLUENCE OF TEMPERATURE ON LIQUID SCINTILLATORS. G.Laustriat and A.Coche.

J. Phys. Radium (France), Vol. 21, No. 5, 487-9 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The effect of temperature on liquid scintillators was investigated for the case when the fluorescence is excited by γ-rays or ultraviolet light. Operating, in each case, with various solvents or solutes, a temperature effect was found at different stages of energy transfer from the solvent to the solute, and on the fluorescence of the solute.

18419 THE EFFECT OF LONG WAVELENGTH ULTRAVIOLET LIGHT AND β-RAYS ON THE FLUORESCENCE OF ANTHRACENE IN VARIOUS SOLVENTS.
L.Herforth and W.Stolz.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 1, No. 7-10, 415-18 (1959). In German.

Fluorescence decreases exponentially with the prior dose of ultraviolet radiation for benzene, acetone, dioxane and other solvents, but larger non-exponential decreases occur with Cl-containing solvents. More concentrated solutions show larger decreases. Some measurements with β-rays show similar results.
S.T.Henderson

18420 VARIATION IN THE FLUORESCENCE OF ORGANIC SOLUTIONS AFTER IRRADIATION BY ULTRAVIOLET LIGHT AND β-RAYS. L.Herforth and H.Hilbig.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 5, 271-7 (1960). In German.

See preceding abstract. In a benzene solution some aromatics show exponential loss of fluorescence with increasing dose of ultraviolet, but others show a very rapid fall for a small dose, followed by a slower exponential. In chlorobenzene some solutes exhibit an increase at higher doses due to increase of fluorescence of the solvent. For exposure of benzene solutions to β-rays the losses are exponential with no initial rapid falls, while chlorobenzene solutions show a greater rate of loss, as for ultraviolet exposure.
S.T.Henderson

PHOTOELECTRIC MEASUREMENT OF THE DEGREE OF POLARIZATION OF FLUORESCENT SOLUTIONS. See Abstr. 18620

18421 PROPORTIONALITY, UNDER CERTAIN CONDITIONS, BETWEEN THE ELECTRICAL CONDUCTIVITY OF INSULATING LIQUIDS AND THE QUANTITY OF WATER CONTAINED IN THEM. R.Guizonnier and F.Taris.
C.R. Acad. Sci. (France), Vol. 253, No. 6, 943-4 (Aug. 7, 1961). In French.

After taking special precautions to eliminate electrode effects and static charges, a linear relationship was found between the electrical conductivity of, and the proportion of water contained in, petroleum ether, carbon tetrachloride and benzene.
R.G.C.Arridge

18422 THEORY OF DIELECTRIC POLARIZATION IN NON-POLAR FLUIDS. A.Isihara.
Physica (Netherlands), Vol. 27, No. 9, 857-71 (Sept., 1961).

The dielectric constant of non-polar fluids does not agree with the Clausius—Mossotti formula. The deviation is calculated taking the induced dipole—dipole interactions into consideration. Since the induced dipole moments suggest that the molecules are most likely deformed, the theories developed by Kirkwood, Yvon and others are generalized in this paper to treat non-spherical molecules. A new mathematical method is introduced, and the dielectric constant is calculated as a function of the molecular anisotropy. In particular the "rotational fluctuation" is found to be composed of two terms, one representing the optical and the other corresponding to the geometrical anisotropy.

18423 ELECTRICAL BREAKDOWN OF LIQUID DIELECTRICS. D.W.Swan.
Proc. Phys. Soc. (GB), Vol. 78, Pt 3, 423-32 (Sept., 1961).

Assuming that electron emission from the cathode and collision ionization in the liquid are both necessary for the electrical breakdown of liquid dielectrics, a criterion for breakdown is developed in which the cumulative effects of the applied field and the space-charge field of the positive ions produce a continuously increasing electron current at the cathode. The present theory differs from earlier similar theories in that the ionization occurring in the liquid is considered to be very small even at breakdown, in agreement with recent conduction measurements. The breakdown criterion shows clearly how the measured electric strength can depend on either the cathode or the liquid. The influence on the breakdown measurements of dissolved oxygen is also discussed, and the quantitative predictions of the theory are compared with measurements of the electric strength of liquid argon.

18424 THE INFLUENCE OF CATHODE AND ANODE SUR FACES ON THE ELECTRIC STRENGTH OF LIQUI ARGON. D.W.Swan and T.J.Lewis.
Proc. Phys. Soc. (GB), Vol. 78, Pt 3, 448-59 (Sept., 1961).

The electric strength of liquefied argon is found to depend a marked degree on the nature of both cathode and anode. This effect was investigated systematically. The cathode is thought influence the strength through the process of electron emission into the liquid, whilst the anode becomes important only if the of emission from the cathode exceeds that at which the anode c accept charge. In this case a high space-charge field is set up the anode which can lower the applied field necessary for break down. By measuring the electric strength of liquid argon conta ing various concentrations of oxygen, it is shown that probably anode space charge is formed only when part of the current bef breakdown is carried by negative oxygen ions. The electric st is found to be very sensitive to small concentrations of oxygen.

18425 THE PRINCIPAL DIELECTRIC CONSTANTS OF T HOMOGENEOUSLY ORDERED LIQUID CRYSTAL PHASE OF p-AZOXYANISOL. W.Maier and G.Meier.
Z. Naturforsch. (Germany), Vol. 16a, No. 5, 470-7 (May, 1961). In German.

The principal dielectric constants of the nematic liquid cry phase of very pure 4,4'-dimethoxyazoxybenzol were measured magnetic field of 2000 G in the frequency range 0.1 to 1.6 Mc/s The results are interpreted with the aid of a theory (Abstr. 105 of 1961). Using the principal dielectric constants and the know refractive index values, the authors determine the molecular di moment and its orientation with respect to the molecular axes. latter is in reasonable agreement with (corrected) values from Kerr effect.
J.G.P

18426 DIELECTRIC LOSSES IN NON-POLAR INSULATIN LIQUIDS DUE TO [CARRIER] ACCUMULATION BOUNDARY LAYERS. J.Jaumann and C.Marnet.
Z. angew. Phys. (Germany), Vol. 13, No. 1, 1-10 (Jan., 1961). In German.

Results of loss measurements on good quality oils and on carbon tetrachloride are reported for the frequency range 50-4000 c/s and for temperatures between 20 and 100°C. An unusu dependence of loss tangent on electrode spacing was found, the losses giving this effect being apparently superimposed on the losses due to the bulk conductivity of the liquid. The additional varied only slowly with temperature and frequency, but increas linearly with electrode spacing. There was no dependence on fi strength between 3 and 15 kV/cm. An explanation of these resu is attempted in terms of an accumulation of space charge adjac to the electrodes.
K.W.Ples

FERROELECTRIC AND PIEZOELECTRIC PROPERTIES O BIOLOGICALLY SIGNIFICANT SUBSTANCES. See Abstr. 1783

18427 DRIFT MOBILITY OF PHOTO-INJECTED ELECTR IN HEXANE—SILICONE MIXTURE.
P.Chong and Y.Inuishi.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1482 (July, 1961).

The dependence of the drift mobility of photo-injected elect on the viscosity was determined at 20°C for mixtures of n-hexa and silicone oil of various proportions.
G.I.W.Lle

18428 A THEORY OF THE ELECTRICAL PROPERTIES O LIQUID METALS. I. THE MONVALENT METALS.
J.M.Ziman.
Phil. Mag. (GB), Vol. 6, 1013-34 (Aug., 1961).

The mean free path of an electron in a liquid metal depends scattering by the ions. The cross-section of each ion depend o "pseudo-potential", which can be estimated from the band gap i solid. If the ions scattered independently, the mean free path w be much too short. But there is strong correlation between the positions of the ions in the liquid, giving rise to coherence betw waves diffracted by adjacent ions. Using simple perturbation theory, one can show that the resistance should depend on the Fourier transform, a(K), of the radial distribution function, and should be smaller than for independent scatterers. The density fluctuations of the liquid also scatter electrons, through imperf screening by the "other electrons" of the Coulomb fields of the ions. This "plasma resistance" is the main effect in liquid Na, where the band gap is small. When this term has been subtract

esisuivities of the other monovalent metals come out according
theory, being approximately proportional to the squares of
pseudo-potentials. The change of resistance on melting is
n to be due to the change in the radial distribution function.
rent ratios of ρ_L/ρ_S can be explained through differences in
cattering cross-sections of ions of different metals, especially
ifferences in the ion-core "pseudo-potentials". The temper-
variation of the resistivity follows from the temperature
idence of a(K). The thermoelectric power in the solid, and in
quid, and its change on melting, all follow qualitatively from
rm of a(K) and of the scattering cross-section for each type
1.

8429 THE RESULTS OF MEASUREMENT OF THE ELECTRICAL CONDUCTIVITY OF ELECTRICALLY
LATED LIQUIDS. G.A.Ostroumov.

ksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 441-4 (Aug., 1961).
ssian.

hydrodynamical explanation is proposed of the violation of
s law which is encountered in measurements of the specific
ric conductivity of some liquids. The explanation is confirmed
e experimental data. [English translation in: Soviet Physics—

430 THE TRANSLATIONAL PART OF THE PROTON RELAXATION IN AQUEOUS SOLUTIONS OF PARA-
NETIC IONS. H.Pfeifer.

Phys. (Germany), Vol. 8, No. 1-2, 1-8 (1961). In German.

From an extension of Torrey's treatment (Abstr. 2868 of 1954)
shown that formulae commonly used for proton relaxation in
us solutions of paramagnetic ions are valid only when certain
nptions are made about the structure of the hydrated ion.

C.J.Ultee

431 NUCLEAR INDUCTION STUDIES ON FLOWING SAMPLES. W.Herms.

Phys. (Germany), Vol. 8, No. 5-6, 280-6 (1961). In German.

Nuclear induction effects were studied on samples in laminar
in a cylindrical tube through the specimen coil. The Bloch
ions are solved for the general case, previous treatments
g assumed a constant velocity profile. The size and shape of
bsorption curves as a function of flow rate, spin—lattice re-
ion time, and the geometry of the apparatus, are determined.
Experimental results agreeing with the theory are claimed but
iven. The demonstration of flow birefringence by means of
ar induction measurements is discussed. It is concluded that
ffect would be small and unlikely to be measurable.

R.G.C.Arridge

432 DYNAMIC NUCLEAR POLARIZATION IN WEAK FIELDS (78 G), FOR SOLUTIONS OF SEMIQUINONES.
ttut, G.Berthet and J.P.Imbaud.

Acad. Sci. (France), Vol. 253, No. 4, 638-40 (July 24, 1961).
ench.

The nuclear resonance of protons in a solution of benzosemi-
ne in alcohol was observed at 78 G using a large amplitude
sweep. The good signal to noise ratio was obtained by employ-
ynamic polarization of the nuclei. The experimental arrange-
is described.

S.A.Ahern

43 ELECTRON PARAMAGNETIC RESONANCE AND PARAMAGNETIC RELAXATION IN LIQUID AND
RCOOLED SOLUTIONS OF Ti^{3+} SALTS.
vvakumov, N.S.Garif'yanov and E.I.Semenova.

ksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1215-20 (Nov.,
. In Russian.

Electron paramagnetic resonance measurements in alcohol and
rine solutions of the salts $TiCl_3.6H_2O$ and $Ti_2(SO_4)_3.4H_2O$
carried out at frequencies 300-9460 Mc/s and at temperatures
0°, 200° and 77°K. Symmetric lines with ΔH dependent on the
nt and on the concentration of the solution were observed in
rcooled solutions at a frequency ν = 300 Mc/s. Broad
metric lines due to the asymmetry of the g-factor were
rved at a frequency of 9460 Mc/s. The values of $g_{\parallel}$ and $g_{\perp}$
determined for supercooled glycerine and alcohol solutions.
ow symmetric lines were observed in dilute liquid solutions.
ation measurements in parallel fields were also carried out at
encies of 300, 17, and 6 Mc/s. The order of magnitude of the
-lattice relaxation time, ρ_1, is estimated, and it is found that
ρ_1 depends both on the solvent and on the concentration of the solution. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 847-50 (May, 1961)].

18434 HYPERFINE STRUCTURE OF ELECTRON PARAMAGNETIC RESONANCE LINES IN SUPERCOOLED SOLUTIONS OF SALTS OF Ti^{3+}. N.S.Garif'yanov and E.I.Semenova.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 28, 337-9 (Aug., 1961). In Russian.

The hyperfine structure of lines in supercooled glycerine solutions of $Ti_2(SO_4)_3$ enriched with Ti^{47} and Ti^{49} was investigated at a frequency ν = 450 Mc/s and a temperature T = 77°K. The spins for the Ti^{47} and Ti^{49} nuclei were obtained and are respectively $I = \frac{5}{2}$ and $I = \frac{7}{2}$. The hyperfine splitting constants $|A|$ and $|B|$ were determined. The hyperfine c.p.r. line structure in liquid alcohol solutions of Ti^{49} could not be resolved at a frequency of 9430 Mc/s and T = 295°K. [English translation in: Soviet Physics—JETP (USA)].

18435 ON THE THEORY OF SPIN—LATTICE RELAXATION IN LIQUID SOLUTIONS OF ELECTROLYTES.
K.A.Valiev and M.M.Zaripov.

Zk. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 756-61 (Sept., 1961). In Russian.

Spin—lattice relaxation of hydrated ions of metals in aqueous solutions due to interaction between the ion spin and internal vibrations of the complex is investigated by stochastic theory methods. [English translation in: Soviet Physics—JETP (USA)].

NUCLEAR POLARIZATION BY "DOUBLE EFFECT" IN THE PRESENCE OF DIFFUSION WHEN THE ELECTRONIC RESONANCE LINE IS INHOMOGENEOUS. See Abstr. 16972

18436 MEAN LIVES OF POSITRONS IN OXIDIZING SOLUTIONS.
J.D.McGervey, H.Horstman and S.DeBenedetti.

Phys. Rev. (USA), Vol. 124, No. 4, 1113-16 (Nov. 15, 1961).

Mean lives of positrons were measured in aqueous chloride solutions, in an attempt to detect oxidation of positronium (Ps) by positive ions. The variation of mean life with concentration and with oxidation potential of the positive ion shows that Ps is oxidized by solutions of $SnCl_4$ and $HgCl_2$, but not by HCl or solutions of ions with lower oxidation potentials. These results indicate that the process is quite similar to the ordinary chemical oxidation process.

18437 THE DOPPLER WIDTH OF EMISSION AND ABSORPTION LINES. M.I.Podgoretskii and A.V.Stepanov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 561-6 (Feb., 1961). In Russian.

Classical and quantum mechanical treatments are given of the Doppler effect on line shape. The possibility is considered of experimental observation of resonance absorption of γ-rays in liquids. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 393-6 (Aug., 1961)].

18438 THE DENSITY OF H_2—D_2 MIXTURES.
V.N.Grigor'ev and N.S.Rudenko.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 757-61 (March, 1961). In Russian.

Measured in the range from the melting point to 20.4°K, and the relative excess volumes $\Delta V/V$ determined. For all mixtures $\Delta V/V < 0$ and is independent of temperature within the experimental accuracy. For an equimolar mixture $\Delta V/V \cong -0.01$. The theoretical calculations of $\Delta V/V$ for the H_2—D_2 system [Trans Faraday Soc. (GB), Vol. 45, 966 (1949) and Abstr. 10505 of 1961] do not agree with the experimental data. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 530-3 (Sept., 1961)].

MECHANICS OF GASES

18439 SELF-SIMILAR RFLATIVISTIC SOLUTIONS FOR THE CASE OF EXACT SYMMETRY. K.P.Stanyukovich.

Dokl. Akad. Nauk SSSR, Vol. 140, No. 1, 77-80 (Sept. 1, 1961). In Russian.

Considers all possible solutions when the motion of a gas obeys the following relations: velocity $u = \xi_1(z)$, specific volume

$V = 1/e^{at}\xi_2(z)$, pressure $p = e^{at}\xi_3(z)$, z = distance, a = specific index, t = time, while ξ_1, ξ_2 and ξ_3 are the independent functions. The classes of solutions are identified and methods discussed. Conditions for exact solutions are also considered; these can be used in the theory of propagation of ultra-relativistic waves. [English translation in: Soviet Physics—Doklady (USA)].

J.K.Skwirzynski

18440 THE INFLUENCE OF ELECTRIC FIELDS ON THE VISCOSITY OF DIPOLAR GASES. J.Bauer.

Acta phys. Austriaca, Vol. 14, No. 2, 140-8 (1961). In German.

A formula for the coefficient of viscosity of a dipolar gas is derived using the kinetic theory of gases. Under conditions of a constant streaming velocity, the coefficient of velocity decreases with increasing applied electric field. T.E.Peacock

18441 CROSS-STRESSES IN THE LAMINAR FLOW OF GASES IN ACCORDANCE WITH MAXWELL'S DYNAMICAL THEORY. M.Reiner.

Bull. Res. Coun. Israel, Vol. 10C, No. 1-2, 2-13 (June, 1961).

In a number of papers Popper and Reiner (1956-9) have described various instruments which show that "cross-sections" are present in the laminar flow of air, i.e., stresses acting in the direction of the velocity of flow and, normal to it, in the direction of the velocity gradient. The theoretical explanation of the effect is still an open problem. The current kinetic theories which take into account second-order effects, such as those of Chapman and Cowling (1952) and of Ikenberry and Truesdell (1956) predict results of opposite sign i.e., pressure in the direction of the flow, or an increase of pressure in this direction and therefore a centrifugal effect and, accompanying this, a reduction of the pressure in the direction of the velocity gradient, or a negative thrust bearing. It is therefore interesting to note that cross-stresses such as mentioned above, resulting in centripetal pumping action and a self supporting thrust bearing action, seem to follow from the "dynamical" theory as developed by Maxwell. This is shown in the present paper by elementary methods using simplifying assumptions. While such procedure cannot be expected to be quantitatively correct, it should not affect the generality of the results in their qualitative aspects.

18442 EFFECT OF THE SHAPE OF THE PORES ON THE DISCHARGE OF A VAPOUR THROUGH POROUS MATERIAL. P.Eyraud.

C.R. Acad. Sci (France), Vol. 252, No. 22, 3386-8 (May 29, 1961). In French.

Experiments are made with water vapour flowing through porous cast aluminium. Examination by electron microscope shows that the pores have a fairly regular cylindrical shape. The rate of discharge is observed at various pressures. In interpreting the results three types of flow are considered, e.g. flow of a vapour phase, of a liquid phase (condensation in capillaries) and of layers of adsorbed water. The significance of these types varies with the size of the pores. R.Eisenschitz

18443 USE OF CIRCULATION BY THERMOSYPHON FOR THE STUDY OF VAPOUR FLOW THROUGH POROUS MATERIAL. J.C.Sapet, C.Daneyrolle and D.Massignon.

C.R. Acad. Sci. (France), Vol. 252, No. 22, 3389-91 (May 29, 1961). In French.

The flow of benzene vapour through porous cast aluminium is investigated and interpreted by methods similar to those applied to water vapour (cf. preceding abstract). In order to maintain the rate of flow without applying pumps, use is made of free convection. The rate of flow is measured with a thermal flowmeter in which an electrically heated wire is cooled by the movement of its gaseous surroundings. R.Eisenschitz

18444 THE "EVOLUTIONALITY" CONDITIONS OF STATIONARY FLOWS. R.V.Polovin.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 394-9 (Aug., 1961). In Russian.

Application of the "evolutionality" conditions to flows in nozzles and to transonic flows permits it to be concluded that a continuous transition from subsonic to supersonic velocity should be possible, whereas transition from supersonic to subsonic velocity is accompanied by the formation of shock waves. Application of the "evolutionality" conditions to an oblique shock wave attached to a wedge indicates that the flow behind the shock wave is subsonic. The "evolutionality" conditions are also applied to exothermal endothermal discontinuities. [English translation in: Soviet Ph JETP (USA)].

18445 THE STATE OF A GAS MOVING IN THE VICINITY A SOLID SURFACE. S.P.Bakanov and B.V.Derya

Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 71-4 (July 1, 1961). In Russian.

The method of solution follows that of Gross, Jackson and Ziering (Abstr. 9039 of 1957). The velocity profile in the vici of a plane wall is determined and hence the phenomenological slip velocity derived. This expression is found in the limit, at large distances from the wall, to coincide with Maxwell's form [English translation in: Soviet Physics—Doklady (USA)

J.K.Skwir

18446 LAMINAR-FILM CONDENSATION ON A FLAT PL IN THE ABSENCE OF A BODY FORCE. R.D.Ces

Z. angew. Math. Phys. (Switzerland), Vol. 11, No. 5, 426-33 (Sept. 25, 1960).

Laminar flow of a saturated vapour passing over a cooled plate was studied for the case of film condensation on the surfa It was assumed that there are no gravitational forces so that t motion of the liquid film resulted solely from the sweeping eff of the adjacent vapour. The shear stress and heat transfer at plate surface were calculated using numerical integration methods, and results given in two diagrams. W.Steckelm

18447 LOW-PRESSURE GAS FLOW IN CONSOLIDATED POROUS MEDIA. I. FLOW THROUGH A POROUS CERAMIC. R.Ash and D.M.Grove.

Trans Faraday Soc. (GB), Vol. 56, Pt 9, 1357-71 (Sept., 1960).

Experiments were carried out near room temperature on pressure gas flow through a porous porcelain ceramic made in form of a cylindrical rod about 0.3 cm in diam. and nearly 50 c length, the flow occurring along the axial direction only. The g used were the inert gases, hydrogen, nitrogen, oxygen, ethane, carbon dioxide and sulphur dioxide. At the highest pressures e ployed (~ 30 cm Hg), viscous (slip) flow was observed, but belo 2 cm Hg this was gradually replaced by molecular streaming. Poiseuille and Knudsen permeabilities are calculated and used determine the mean pore radius and specific surface area of th ceramic by the methods of Adzumi, of Carman and Arnell, and Kraus and Ross. Using the method of Barrer, the pore propert are also determined from the transient state of flow measured the same experiments, and all the flow results are compared w the surface area determined from low-pressure nitrogen-adso tion isotherms by the standard procedure of Brunauer, Emmett Teller. For the permanent gases, it is shown that the product steady-state permeability and the transient-state time-lag rema substantially constant throughout the pressure range studied. Anomalous results are obtained for sulphur dioxide and, to a m less marked degree, for carbon dioxide. It is shown that these sults can provide information about the adsorption occurring.

18448 RESISTANCE IN POTENTIAL FLOW WITH CIRCULATION. II. SYMMETRICAL CARAFOLI A JOUKOWSKI AEROFOILS. N.L.Ghosh and H.K.Chatterjee.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 626-41 (Nov. 26, 1

Following Ghosh's theory of resistance in potential flow of real fluids, formulae are developed expressing the lift and dra coefficients and their ratio in terms of the angle of attack, for Carafoli and the Joukowski symmetrical aerofoils. A comparis of the results with those for the model R.A.F. 34, which is very nearly a symmetrical aerofoil, are made and the results show very good agreement for angles of attack up to 16°.

18449 RESISTANCE IN POTENTIAL FLOW WITH CIRCULATION. III. GENERAL JUKOWSKI AERO N.L.Ghosh and H.K.Chatterjee.

Proc. Nat. Inst. Sci. India A, Vol. 27, No. 2, 144-54 (March 26, 1961).

An extension of the work described in the previous abstra made to the case of the General Jukowski aerofoil, under the s conditions of circulation and angle of attack.

18450 NUMERICAL CALCULATION OF THE DISPLACEMENTS OF A STRATIFIED AIRSTREAM CROSSING A RIDGE OF LL HEIGHT. J.S.Sawyer.
t. J. Roy. Meteorol. Soc. (GB), Vol. 86, 326-45 (July, 1960).
Numerical computations have been made of the solutions of the tion

$$\frac{\partial^2\psi}{\partial z^2} + \frac{\partial^2}{\partial x^2} + l^2\psi = 0$$

h describes the stream lines in two-dimensional flow of small itude in a stratified airstream. Solutions are computed for ›us variations of the parameter l as a function of height. gβ $U^2 - U^{-1}\partial^2 U/\partial z^2$ is function of the wind and temperature ıtions with height in the airstream). To render the mathematical lem determinate the value of l^2 is assumed to be constant above n up to unlimited heights and by specifying the form of solution e 16 km consistent solutions are obtained for the troposphere affected by the value of l^2 assumed at high levels. The solu- include lee-wave trains which diminish in amplitude down- ım as well as those of constant amplitude. The method of ion results in the former appearing on the downstream side of idge only. (It is assumed that waves of constant amplitude can ar only on the downstream side). Some typical displacements of tream lines are illustrated. They are similar to those computed ueney (1947) and Scorer (1949) but it is demonstrated that lee s may arise from variations of l^2 with height additional to those ified by these authors.

ock Waves

18451 SHOCK WAVES IN STARS.
S.A.Kaplan.
ı. Soc. Roy. Sci. Liege (Belgium), Sér. cinquième, Vol. III, 7 (1960).
Gives summary of results reported earlier (Abstr. 18856 of) on physical properties of shock waves where significant action occurs between radiation and mass flow. Three types ›ocks are considered with relation to specific models of red s: (1) detonation—recombination shocks where the kinetic gy of flow is supplied by recombination energy; (2) radiatively ›d shocks where the shocks emit as radiation a considerable ortion of their energy; (3) shocks in a degenerate electron gas.
M.McChesney

18452 THE KINETIC THEORY OF SHOCK WAVES.
G.Ya.Lyubarskii.
›ksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1050-7 (April, 1961). ıssian.
The structure of a low-intensity shock wave in a monatomic gas ›tained at large distances from the wave front. The calculation .sed on a kinetic equation with a simplified collision integral ıining a constant collision time. It is shown that in this case ›us physical quantities approach their limiting values at infinity a slower rate than in the hydrodynamic theory. Therefore, if :inetic equation is replaced by a finite system of ordinary rential equations it is impossible, in principle, to obtain the ect asymptotic solutions of the kinetic equation. [English slation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 740-5 , 1961)].

8453 LOCAL DESCRIPTION OF THE FLOW BEHIND A STEADY, TWO-DIMENSIONAL, CURVED SHOCK WAVE.
ısimoto and S.Morioka.
ıys. Soc. Japan, Vol. 16, No. 8, 1616-24 (Aug., 1961).
The local properties of the rotational flow field behind a ły, two-dimensional, curved shock wave which occurs in the rsonic uniform flow of a perfect gas are considered. The ›s of the flow field in the vicinity of a point on a shock wave are ribed as a power series about this point under the assumption the shape of the shock wave is regular. The hodograph trans- ıation of such a field becomes singular at the points where the bian relating to the transformation vanishes. The fields in the ıity of such singular points are discussed in detail.

18454 UNSTEADY SHOCK PROPAGATION IN A RELAXING GAS. D.A.Spence.
Proc. Roy. Soc. A (GB), Vol. 264, No. 1317, 221-34 (1961).
A study is made of the motion of the shock wave produced when a piston is impulsively set in motion with constant velocity into a diatomic gas at rest, conditions being such that behind the shock there is a zone of vibrational or dissociational relaxation. The dissociation case is treated by the method of linearized characteristics, using a form for the rate equation due to Freeman (1958), while the vibrational case is included in a discussion in which the third-order equation for acoustic disturbances derived by Chu (1958) is applied to the flow behind the shock. It is shown that in either case the initial speed of the shock is that corresponding to frozen flow between it and the piston, but that the lower speed calculated from equilibrium thermodynamics is approached at large times. Distributions of pressure and velocity between the piston and the shock are found: at long times after the start of the motion these are precisely those given by the Bethe—Teller (1941) theory for partly dispersed shock waves. Some applications to other shock motions are discussed.

18455 PROPAGATION OF SHOCK WAVES IN INHOMOGENEOUS GASES. III. SPHERICAL SHOCK WAVES. Y.Ôno.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 825-9 (Oct., 1960).
For Pt II see Abstr. 10774 of 1961. The propagation of spherical shock waves in the stellar interior is considered, extending the method developed in Pts I and II. A differential equation of the shock strength is derived, which can be applied to any stellar models. It is found that the spherical damping effect is pronounced near the centre of stars, and this guarantees the stability of the stellar core in general. In the envelope, this effect becomes negligible, and it is justified to treat the shock waves near the stellar surface as plane.

SHOCK WAVE PROPAGATION IN T-SHAPED DISCHARGE TUBES. See Abstr. 1878C

ON THE THEORY OF SHOCK WAVE PROPAGATION AND CHANNEL FORMATION IN STRONG SPARK DISCHARGES. See Abstr. 18785

COLLISIONLESS PLASMA SHOCK WAVES. See Abstr. 18841

FUNDAMENTAL RELATIONS ACROSS A STRONG STEADY SHOCK WAVE GIVING RISE TO A DISCONTINUITY IN CONDUCTIVITY. See Abstr. 19011

18456 OSCILLATORY PHENOMENA IN UNSTABLE DETONATION WAVES. C.Brochet, J.C.Leyer and N.Manson.
C.R. Acad. Sci. (France), Vol. 253, No. 4, 621-3 (July 24, 1961). In French.
Continuation of earlier work on unstable detonation waves [ibid., Vol. 250, 3949 (1960)]. Optical studies of the luminous striae found in the gas suggest the presence of forced vibrations between the shock front and the combustion wave. These oscillations are found to have the same frequency as transverse waves in the burning gas. A theoretical analysis of these oscillations based on pressure fluctuations in a cylindrical gas column is given to support the experimental results.
M.McChesney

18457 INVESTIGATION OF SPINNING DETONATION AND DETONATION STABILITY. R.E.Duff.
Phys. of Fluids (USA), Vol. 4, No. 11, 1427-33 (Nov., 1961).
The stability of a detonation wave and the nature of a spinning detonation were investigated by observing the patterns inscribed by the wave in soot coatings on films located on the circumference of the detonation tube and on the end plate. The detonation instability reported by others persists to an initial pressure of over 2 atm and to wave velocities at least 75% greater than the equilibrium value. The wave front of a simple spinning detonation contains a complex Mach interaction with wave inclinations as high as 37° to the tube diameter. The acoustic theory of spinning detonation does describe high-order spin if it is assumed that two or more modes of vibration coexist.

18458 STRUCTURE OF DETONATIONS IN DILUTE SPRAYS. F.A.Williams.
Phys. of Fluids. (USA), Vol. 4, No. 11, 1434-43 (Nov., 1961).
Solutions to the differential equations governing the structure

of a steady-state detonation in a spray are obtained both numerically and by means of analytical approximations for the case in which the droplets in the spray burn heterogeneously. It is shown that, for reasonable droplet burning rates, the detonation structure corresponds almost precisely to the spray analogue of the von Neumann hypothesis of a shock wave followed by a deflagration zone. The size of the burning region is demonstrated to be large enough to cast doubt upon the stability of a spray detonation not supported to a significant extent by purely gaseous reactions.

THE EFFECT OF AN EXPLOSION IN A COMPRESSIBLE FLUID UNDER GRAVITY. See Abstr. 18380

18459 SHOCK TUBES.

J.K.Wright.

London: Methuen; New York : John Wiley (1961) vii + 164 pp.

The purpose of this monograph is to give some idea of the theory of shock waves, the principles of operation of shock tubes and an account as to some of the more important investigations using shock tubes. Chapter headings include the following: one dimensional compressible gas flow; theory of the shock tube; shock-tube measurement techniques; reflection, refraction and diffraction of shock waves; shock-front structure; production of strong shock waves; strong shock-wave investigations. Each chapter concludes with a useful list of references. There are author and subject indexes.

18460 THE ORIGIN OF THE IONIZATION OBSERVED IN ELECTROMAGNETICALLY DRIVEN SHOCK TUBES.

M.Cloupeau.

C.R. Acad. Sci. (France), Vol. 253, No. 10, 1160-2 (Sept. 4, 1961). In French.

Discusses the radiation emitted behind shock waves generated in electromagnetically driven shock tubes. Experiments were made in a straight tube containing gases (hydrogen and helium) which, by differential pumping, were not allowed to mix. Time and space resolved spectrographic studies suggest that the radiation is not due to thermal excitation of the shock processed gas but is characteristic of the gas in which the initial discharge took place. It is concluded that the initial discharge plasma is bodily projected down the tube. M.McChesney

GASEOUS STATE

18461 AN ACOUSTIC MODEL OF DIFFUSION IN GASES. I.

L.Kotin.

Molecular Phys. (GB), Vol. 4, No. 5, 401-12 (Sept., 1961).

Principles of macroscopic acoustical theory are applied to the calculation of the friction constant of a dilute gas of rigid spheres. In the model molecular motions are perturbed by acoustic disturbances arising from the occurrence of density fluctuations in the equilibrium fluid. The friction constant calculated is found to have the same parametric form but a substantially lower numerical coefficient when compared with the result of Chapman and Enskog.

18462 ON BOURRET'S HYPOTHESIS CONCERNING TURBULENT DIFFUSION.

P.H.Roberts.

Canad. J. Phys., Vol. 39, No. 9, 1291-9 (Sept., 1961).

An integrodifferential equation proposed on heuristic grounds by Bourret (1959) for turbulent diffusion in gases is compared with a similar equation which was derived by Roberts (1960) from the application of Kraichnan's approximation (1959) to the exact equations of turbulent diffusion, and which is itself closely related to an equation postulated by Bourret as a result of further heuristic arguments. A simple generalization of Taylor's model of turbulent diffusion is discussed, and is found to obey Roberts' equation but, unless the spacial correlation between the velocity of the diffusing particles is zero, it does not obey the equation initially proposed by Bourret.

18463 KIRKENDALL EFFECT IN GASES.

E.A.Mason, L.Miller and P.C.Carman.

Nature (GB), Vol. 191, 375 (July 22, 1961).

The data from the experiment previously described [Nature (GB), Vol. 186, 549 (May 14, 1960)], in which the motion of fine partic of ammonium chloride smoke in a diffusing gas mixture was th considered evidence for a Kirkendall effect, have now been re-examined, since McCarty and Mason (Abstr. 176 of 1961) have established that the usual phenomenological theory of the above effect cannot be correct for gases. It is now shown that the cla kinetic theory of gases is capable of accounting for the data quantitatively. H.H.Ho

18464 THERMAL DIFFUSION IN SOME MIXTURES OF IN GASES.

K.E.Grew and J.N.Mundy.

Phys. of Fluids (USA), Vol. 4, No. 11, 1325-32 (Nov., 1961).

Thermal diffusion was investigated experimentally in sever binary mixtures of inert gases, especially at low "reduced" tem tures, and the results compared with theoretical values based o Lennard-Jones and exponential-six molecular models. The the diffusion factor for krypton—argon mixtures is found to pass th a positive minimum value; this behaviour, theoretically possibl has not previously been observed. Other mixtures examined ar xenon—krypton and krypton—nitrogen; the mixtures of radon wit neon, argon, and krypton; and the isotopic mixture Ne^{22}—Ne^{20}.

18465 THE VALIDITY OF THE LAW OF CORRESPONDIN STATES.

J.H.M.Levelt.

Ned. Tijdschrift Natuurkde (Netherlands), Vol. 26, No. 8, 250-3 (Aug., 1961). In Dutch.

The conditions under which a law of corresponding states will be valid are briefly listed, and a brief discussion is given o recent work on this law, using measurements on inert gases (especially argon and xenon) over a wide range of temperatures and at densities well above the critical. It is pointed out that the observed deviations from this law should make one wary of applying this law too freely, particularly to liquids and strongly compressed gases. D.ter

18466 GAS PROPERTIES AT HIGH TEMPERATURES ON EXPONENTIAL MODEL.

P.K.Chakraborti.

Indian J. Phys., Vol. 35, No. 7, 354-60 (July, 1961).

High temperature viscosity data were utilized to obtain the potential parameters for the exponential model for He, A, N_2, O_2 and CO_2. These parameters can reproduce the experimental viscosity data at high temperatures more satisfactorily than the parameters determined from scattering experiments. The comb ation rules proposed for the exponential model were tested in re to the high temperature inter-diffusion coefficient and the result so obtained are discussed.

18467 THE RATE OF MOLECULAR COLLISIONS IN GASE COMPOSED OF "SOFT" MOLECULES.

J.S.Rowlin

Molecular Phys. (GB), Vol. 4, No. 4, 317-20 (July, 1961).

Equations are derived for the number of collisions per unit time in which the centres of the molecules approach to some arbitrary distance, d, or less, for molecules with spherical intermolecular potentials. The collision rates based upon this criterion of closeness-of-approach have a different dependence on temperature from those based upon cross-sections determine from the viscosity. It is suggested that the rates calculated in t paper are the more appropriate for the discussion of experiment on the exchange of molecular energy and on the kinetics of chem reactions.

18468 A SIMPLIFIED CLUSTER EXPANSION FOR THE CLASSICAL REAL GAS.

N.G.van Kampen.

Physica (Netherlands), Vol. 27, No. 8, 783-92 (Aug., 1961).

Mayer's expansion of the partition function of a classical re gas in terms of irreducible cluster integrals is derived by a simpler and more direct method. The two principal features of method are the following. (i) The partition function is expanded an infinite product rather than a series. As a result the expone form is obtained immediately: there is no need to sum up infini sets of graphs. Disconnected graphs never enter the treatment. (ii) The calculation leads directly to the canonical N-particle partition function. Neither the fugacity nor the reducible cluste integrals are introduced. The same method is also used to find expansion of the pair-correlation function. Finally it is applied the partition function of a real gas in an external potential field.

18469 SOME PROBLEMS IN RELATIVISTIC GAS DYNAMICS OF CHARGED PARTICLES. V.N.Tsÿtovich.

. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1325-32 (May, 1961). Russian.

Some general problems in relativistic gas dynamics of charged ticles in external and self-consistent fields are considered. An logue of potential motion is found and the theorem of conservation magnetic flux along a liquid contour is generalized. The one-ensional problem of break-up of a charged layer in external lds is solved. [English translation in: Soviet Physics—JETP A)].

8470 A NOTE ON NON-EQUILIBRIUM SPECIES CONCENTRATIONS IN AIR. M.J.Beran.

tmos. terrest. Phys. (GB), Vol. 21, No. 4, 293-5 (July, 1961).

Calculations are made of the rate of approach to equilibrium of itrogen-oxygen mixture at 10^{-5} atmospheric density, initially 000°K in thermodynamic equilibrium, when the temperature is ckly reduced to 5000°K so that only a minor change of total ticle density is produced. Considering only fast particle-serving two-body reactions, an asymptotic solution is reached ich differs for most of the species by an order of magnitude n the equlibrium values at 5000°K. It is concluded that the rate pproach of equilibrium is governed by the fastest non-particle-serving reaction. G.M.Brown

HEAT CAPACITY OF WATER VAPOUR AT HIGH TEMPERURES AND HIGH PRESSURES. See Abstr. 18395

18471 THE VELOCITY OF SOUND IN GASEOUS MIXTURES. V.Vrkijan.

riod. math.—phys. astron. (Yugoslavia), Vol. 2, No. 4, 299-301 60). In German.

Purports to show that a formula already published for the ocity of sound in mixtures of ideal monatomic gases holds for er gases provided their molecules have similar degrees of edom. The specific heats of the individual gases are calculated terms of the gas constants and, if the number of degrees of edom of each gas are identical, they cancel, and the equation for velocity of sound in the gaseous mixture then becomes identical h that for a mixture of monatomic gases. The equation only lies over the temperature range in which the specific heats are roximately constant. A.C.Whiffin

INTERFEROMETER MEASUREMENT OF ULTRASONIC SORPTION IN GASES. See Abstr. 18531

NEGATIVE ABSORPTION COEFFICIENTS IN DISCHARGES IN S MIXTURES. See Abstr. 18772

18472 .CO-OCCURRENCE OF POSITIVE AND NEGATIVE JOSHI EFFECT IN IODINE VAPOUR.

.Prasad, B.B.Prasad and S.Raja Rao.

ci. Res. Banaras Hindu Univ. (India), Vol. 11 (1), 10-21 60-61; publ. Dec., 1961).

A detailed investigation of the influence of light, frequency and illographic studies of the Joshi effect in iodine vapour at a ssure of 0.202 ± 5% mm Hg subjected to an ozonizer discharge ealed the simultaneous occurrence of positive and negative remental currents localised in the two half waves at potentials nd below V_m the threshold potential. This potential was found e 545 V (r.m.s.) where the frequency was 50 c/s. A compresive theoretical survey suggested that the capture of photoctrons occurs near the negatively charged wall by the photosociation of a molecular layer of iodine vapour adsorbed on the face of the glass. W.G.Townsend

18473 INFLUENCE OF DIRECTIONAL IRRADIATION ON, AND THE ABSORPTION OF LIGHT IN THE PRODUCTN OF, JOSHI EFFECT IN MERCURY VAPOUR. B.N.Prasad.

sci. Res. Banaras Hindu Univ. (India), Vol. 11 (1), 103-8 60-61; publ. Dec., 1961).

Studies of the Joshi effect $-\Delta i$ under directional irradiation, her transverse ($-\Delta i_T$) or longitudinal ($-\Delta i_L$) in mercury vapour re made. A lower value of relative Joshi effect was found for the gitudinal irradiation. The ratio $-\%\Delta i_T/-\%\Delta i_L$ was found to be ependent of the applied potential. An explanation based on the pendence of photoelectric emission on the direction of irradiation developed to account for the preceding results. W.G.Townsend

18474 THERMOELECTRIC PROPERTIES OF A GASEOUS SEMICONDUCTOR. V.G.Yur'ev.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2929-31 (Nov., 1960). In Russian.

Presents preliminary results to check the theory of Moĭzhes and Pikus (Abstr. 15067 of 1960). A graph shows the saturation current versus inverse temperature for Cs pressures of 1 mm and 4×10^{-4} mm Hg and cathode temperatures between 1100 and 2200°K. For the higher pressure agreement with theory is good. For $T < 1700$°K scattering by atoms is dominant, at higher temperatures scattering is by ions. For measuring the mobility and thermo-e.m.f. the anode and cathode could both be heated to 1500-2400°K. The scattering cross-sections agree with those derived from the first set of measurements. The agreement between the experimental and theoretical values of the thermoelectric power shows that the temperature of the gas is close to that of the electrodes. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

THEORY OF DIELECTRIC POLARIZATION IN NON-POLAR FLUIDS. See Abstr. 18422

18475 TRANSFER PHENOMENA IN A PARAMAGNETIC GAS. Yu.Kagan and L.Maksimov.

Zh. eksper. teor fiz. (USSR), Vol. 41, No. 3(9), 842-52 (Sept., 1961). In Russian.

Develops the kinetic theory of a paramagnetic gas in an arbitrary magnetic field. A kinetic equation is derived which takes into account rotational degrees of freedom, discreteness of the magnetic momentum and also the dependence of the scattering cross-section on the angle between the direction of the molecular moment and the direction of the relative velocity which is of decisive importance for the problem under consideration. With the thermal conductivity problem taken as an example, a general method for solving the kinetic equation is developed. An explicit expression for the thermal conductivity tensor in a magnetic field is deduced and comparison with experimental results on the Senftleben effect (1930) is carried out. [English translation in: Soviet Physics—JETP (USA)].

18476 PROTON SPIN—LATTICE RELAXATION IN POLYATOMIC GASES.

M.Bloom, M.Lipsicas and B.H.Muller.

Canad. J. Phys., Vol. 39, No. 8, 1093-1109 (Aug., 1961).

The proton spin—lattice relaxation time T_1 was measured in gaseous samples of methane, ethylene, and ethane as a function of pressure at room temperature and also at 193°K for methane. In the pure gases T_1 is proportional to density, ρ, at low densities indicating that intramolecular interactions couple the spin systems to the lattice, as is the case in hydrogen gas. T_1/ρ at low densities gives information on the mean square angle through which the molecules are rotated per collision. Relaxation due to paramagnetic O_2 is observed at higher densities when oxygen gas is added as an impurity. The relaxation probability per collision with an oxygen molecule is about 5 times larger for the ethylene—oxygen system than for the other two systems studied. This anomaly is discussed in terms of the theory of Oppenheim and Bloom (Abstr. 5033 of 1960; 9410 of 1961). It is shown that a study of the temperature dependence of T_1 due to O_2 impurities provides a new way of obtaining detailed information on the Lennard-Jones parameters for the interaction between O_2 and the solvent molecules.

VACUUM PHYSICS

18477 THE DEVELOPMENT OF THE TECHNOLOGY OF EXTREMELY LOW PRESSURES. A.Venema.

Ned. Tijdschrift Natuurkde (Netherlands), Vol. 26, No. 5, 142-9 (May, 1960). In Dutch.

Reviews the history and the present state of the art of ultra-high vacuum technology. Ionization gauges of the Alpert type, ion getter pumps, magnetron gauge by Redhead, omegatron residual gas analyser are described and evaluated in detail. The author regards He diffusion as the limiting factor determining the ultimate vacuum in glass systems. According to the author, He penetration through glasses of high alkali content and soft glasses is much smaller than through Pyrex. Alumina silicate glass is reported as having a particularly low He diffusion rate. The author obtained pressures of about 10^{-10} mm Hg with oil diffusion pumps and zeolite-charged traps, or by means of a metal mercury vapour pump, in which the rubber O-ring was replaced by a copper seal (a liquid-nitrogen trap was used in this case).

F.R.Walter

18478 EVOLUTION AND ABSORPTION OF GASES IN ELECTRON TUBES. R.H.Collins and J.C.Turnbull.

Vacuum (GB), Vol. 10, No. 1-2, 27-30 (Feb.-April, 1960).

Gas-evolution effects in vacuum tubes have been determined by use of the gas-collection method of Morrison, in which evolved gases in an operating tube are collected with a mercury pump, stored in its fore-vacuum system, and measured with a mass spectrometer after many hours of tube operation. The speed of absorption of the tube for various gases has also been determined by simultaneously leaking gases into the tube and using the same collection system. In this way the partial pressures of gases and their internal evolution and absorption rates in the operating tube were found. These techniques were applied to a practical vacuum tube, the 21CYP22 colour-television picture tube. Typical partial pressures of gases determined during electrical operation of the tube were: hydrogen, 10^{-8} torr; nitrogen (including a small fraction of carbon monoxide), 10^{-9} torr; and oxygen, 2×10^{-11} torr. Oxygen is present only when the tube is scanned, and is evolved by non-metallic bulb surfaces which are bombarded with high-voltage electrons. Self-absorption of the tube for oxygen is very rapid (pumping speed is 3000 l/sec). Thus, oxygen partial pressure is maintained at such a low level during operation of this tube that there is no effect on performance of the oxide cathode.

18479 SYSTEM DESIGN AND THE CHOICE OF MATERIALS FOR THE "NIMROD" VACUUM SYSTEM. S.H.Cross.

Vacuum (GB), Vol. 10, No. 1-2, 86-91 (Feb.-April, 1960).

The dimensions of the vacuum vessel were determined; calculations relating duct size to pumping speed and gas evolution rate were carried out and the results of these are presented. Pumping units using 60 cm diameter oil vapour diffusion pumps were designed and are now being produced. Tests of the first ones show that they are capable of attaining ultimate pressures (with no gas load) of 3×10^{-7} torr. During investigations to discover the most suitable material with which to make the vacuum vessel, determinations of the gas evolution rates of various polymers were carried out and certain of the epoxy resins with glass-fibre reinforcement are the best materials so far found, partly because of their high strength to volume ratio. Work was carried out to show the effect that irradiation has on the mechanical strength and gas evolution rate of these materials. Techniques are being developed to produce laminates in the workshop which are free from voids that may cause leakage. The gas evolution rates obtained from these epoxy resins are higher than can be tolerated if the requisite operating pressure of 10^{-6} torr is to be maintained in the vacuum vessel and it is necessary to mask the surface exposed to the vacuum in order to reduce the amount of gas evolved, a technique which has already been applied in the "Saturn" proton synchrotron at Saclay using stainless steel strip, but the different design parameters of "Nimrod" calls for different techniques and considerable attention is being given to this.

18480 THE GAS SORPTION CHARACTERISTICS OF PENNING PUMPS AND TITANIUM FILMS.

L.Holland and A.Harte.

Vacuum (GB), Vol. 10, No. 1-2, 133-40 (Feb.-April, 1960).

The gas sorption characteristics of evaporated Ti-films about 100 A thick and of a Penning pump with titanium electrodes were studied and compared. The Penning pump also served as an ion-source with the Ti-films. The sorption apparatus consisted of a bakeable stainless steel getter chamber of 1400 cm^2 area and a Penning pump of 75 mm diameter. The vacuum seals were made with metal gaskets and the pressure measured with a hot filament ion-gauge. The gas to be sorbed was admitted to the getter chamber from a reservoir via a calibrated leak. Sorption rates were measured in the pressure interval 0.001-1 μ Hg. The pumping speed of an evaporated Ti-film alone was negligible (< 0.1 l.sec^{-1}), but greatly enhanced when the Penning ion-source was in operation as previously found by Gale. Inert gases were only sorbed by the Penning pump. Instantaneous speeds measured at 10^{-6} torr for fresh Ti-films with the ion-source in operation were, in l.sec^{-1}, as follows: Air, 56; N_2, 56; O_2, 56; H_2, 234. When the sorption rates of either the Penning pump alone or the Penning pump with a Ti-film were plotted in terms of mass sorption rates (litre microns/sec) as a function of pressure it was found that the resultant curves were parallel to the ionization current versus pressure curve of the Penning discharge, i.e. the mass sorption rate at a given pressure was directly proportional to the dischar current at that pressure. The sorption characteristics of mixed gases were studied to find the effect of one molecular type on th clean up of another. It is shown that the sorption rate of hydroge is reduced by the presence of organic vapours, e.g. methane. Sorption rates were also measured for gas mixtures of argon an hydrogen, and nitrogen and "Calor" gas (butane). Measurements were rendered difficult when using hydrocarbon and gas mixtures due to the uncertainty in determining the sensitivity factor to be used with the ion-gauge. The role of ionization in enhancing the gas sorption rate is discussed by Holland in an appendix. The increase in the rate of clean up by titanium was not due to ions flowing to the film because the getter chamber was at a positive potential. The high sorption rate of H_2, O_2, and N_2 when ionized was attributed to their atomization in the Penning discharge. Thi films of titanium are composed of densely packed grains and the enhanced rate of clean up is attributed to the atomic gas being able to penetrate the interstices between the grains and reaction products on the porous film.

18481 PHYSICAL PROCESSES IN SMALL TITANIUM ION PUMPS. R.O.Jenkins and W.G.Trodden.

Vacuum (GB), Vol. 10, No. 4, 319-28 (Sept., 1960).

Experiments with small ion pumps in which titanium is continuously deposited are described. Two types were investigated, the first being a conventional thermionic ionisation gauge with titanium evaporating from a directly heated source in the envelop and the second a Penning type of discharge tube in which titanium was sputtered from the end plates. In the first type all the gases and vapours tested were pumped by ion burial and all except argo were also pumped by adsorption onto the already deposited titaniu film and then covered by the arriving titanium. In addition the ho tungsten could combine chemically with oxygen and also convert hydrogen into the atomic form which was then able to diffuse into the titanium. Water vapour and organic vapours were also decom posed by the hot tungsten. In the Penning discharge pump the spe of pumping was constant for each gas over a wide range of pressures, and depended on the titanium sputtering rate and rate of adsorption of the various gases. It was found that appreciable desorption of pumped gases took place in the sputter-ion pump but could be made negligible in the evaporation-ion pump.

18482 NEW EQUIPMENT FOR VACUUM TECHNIQUE. H.Beetz.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 1, No. 7-10, 467-73 (1959). In German.

Pumping speed data are given for the Roots pump which has been tested in the Institut für Gerätebau. Two-stage Roots combinations exhibit constant pumping speed in the region betwee 10^{-1} and 10^{-5} torr. A report is given on an examination of a molecular vacuum pressure meter.

S.Tolans

18483 UNRELIABILITY OF IONISATION GAUGES AND ITS CONSEQUENCES. J.Groszkowski.

Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 9, No. 4, 235-7 (1961).

Outgassing of the Bayard—Alpert ionization gauge is shown to be difficult if pressures in the range between 10^{-4} and 10^{-7} tor have to be achieved. In a vacuum system in which pressure could be reduced from 5×10^{-5} to 5×10^{-7} torr in 20 min when the B-A gauge was used, an equal reduction could be made in 100 sec and 4×10^{-8} torr achieved in 12 min when only the pulse compres sion thermal vacuum (PCT) gauge was used — as proposed by the author in a paper to the International Congress on Vaccum Techniques and Applications held in Paris, June 20-24, 1961.

A.Sczaniec

18484 A SIMPLE MEASUREMENT DEVICE OF HIGH REPRODUCIBILITY FOR IONIZATION GAUGES.

G.Krause.

Elektron. Rundschau (Germany), Vol. 15, No. 6, 264-5, 269 (June, 1961). In German.

An emission regulator and low-current amplifier is described for the Heraeus design of the Bayard-Alpert-type gauge. The oility, over the valve life of 5000 hr is thought to be such that ors of pressure reading are below 3%. A.H.W.Beck

18485 PARTIAL PRESSURE VACUUM GAUGE UTILIZING THE PRINCIPLE OF THE ELECTRICAL MASS FILTER.

.Günther.

cuum (GB), Vol. 10, No. 4, 293-309 (Sept., 1960). In German and glish.

The operating principle of the electrical mass filter previously estigated by Paul, Reinhard and Zahn (Abstr. 8059 of 1958) is plained and its advantages as a partial pressure vacuum gauge operation up to relatively high pressures (10^{-3} torr) is discussed. tails are given of an instrument with a resolving power up to ss 80 and the behaviour of an ion source of the thermionic ctron collision type is compared with that of a cold-cathode nning type. Some results obtained in the measurement of gas nposition during the vacuum drying of electrical insulating paper given as an example of possible applications of the mass filter. W.Steckelmacher

18486 IMPROVEMENT IN OPERATION WITH McLEOD GAUGE.

N.A.Florescu.

cuum (GB), Vol. 10, No. 4, 329-30 (Sept., 1960).

To improve the method of control of the mercury level in a ort McLeod gauge a non-return valve was fitted in a by-pass tween the mercury reservoir and the measuring head. This nsisted of a mercury covered sintered glass disc so that the essure in the reservoir is never lower than in the gauge head. W.Steckelmacher

18487 A TETRODE IONIZATION GAUGE.

P.Schwerdtfeger.

cuum (GB), Vol. 10, No. 4, 330-1 (Sept., 1960).

This was made to obtain a simple method of electron current control construction is described with electrodes in the form of tungsten irals. With the electrical circuit used, a pressure change from $^{-5}$ to 10^{-4} torr resulted in an electron current change of 3.5%. W.Steckelmacher

18488 USE OF A TEST DIODE AS A MEANS OF CONTROL FOR THE MATERIALS USED IN THE CONSTRUCTION F ELECTRON TUBES.

J.P.Freytag.

acuum (GB), Vol. 10, No. 1-2, 40-8 (Feb.-April, 1960). In French.

After a brief description of the diode, it is shown that the fluence of the ambients reveals three different types of behaviour a $I^{2/3}$ plot, where the available useful current (under space charge mitation) is limited either by the commencement of the sparking enomenon or by saturation. The influence of the operating onditions (d.c. or pulsed operation, pulse length, repetition equency) on the current where the sparking occurs are demonrated and the results obtained with certain anode materials are dicated; i.e: iron, Kovar, titanium, molybdenum, copper, atinum and nickel. The best anode materials are platinum and ckel; in this case, in pulsed operation, a current density of more an 100 A cm^{-2} was obtained, the limitation occurring not by aturation, but by sparking. Finally, the influence of the glass used s the diode envelope is shown, and the diode is shown to act as a elatively simple control device. Nevertheless, when the nature of e ambients are pointed out, more improved devices should be plied, such as the mass-spectrometer.

18489 SIMPLE FLOW REGULATOR FOR EXTREMELY LOW GAS FLOWS.

C.B.Avera, Jr.

ev. sci. Instrum. (USA), Vol. 32, No. 8, 985-6 (Aug., 1961).

A simple manometer type attachment to the Saltzman and ilbert [American Industrial Hygiene Association Quarterly, Vol. 20, 79 (1959)] gas flow regulator is described. This attachment cilitates the control of gas flows as low as 0·01 ml min^{-1}. F.A.Baker

18490 RESIDUAL GASES IN VACUUM SYSTEMS.

A.Klopfer, S.Garbe and W.Schmidt.

acuum (GB), Vol. 10, No. 1-2, 7-12 (Feb.-April, 1960).

Investigation of the gas composition in sealed-off high and ltra-high vacuum systems with the aid of the omegatron showed hat the gas evolution of the materials and interactions between the ases and the surfaces determine the kind of gases which are resent. Such interactions are: adsorption, chemical and exchange eactions. The results obtained on radio tubes, TV picture tubes and systems consisting of glass and metal only are given. It appears possible to classify the composition of residual gases on the basis of the conditions prevailing in the systems in question.

18491 THE INVESTIGATION OF RESIDUAL GASES IN VACUUM SYSTEMS.

S.P.Wolsky and E.J.Zdanuk.

Vacuum (GB), Vol. 10, No. 1-2, 13-21 (Feb.-April, 1960).

Considerable information was obtained concerning the origin of residual gases in evacuated systems. The experimental equipment involved in this research included: (1) an omegatron mass spectrometer, (2) a sensitive quartz microbalance, (3) an apparatus for determining the adsorptive properties of getter films, and (4) associated vacuum systems. Preliminary data concerning the residual gas content of miniature electron tubes is presented. The application of the omegatron to the study of gases generated during tube processing and lifetime is outlined briefly.

18492 RESIDUAL GASES IN PICTURE TUBES.

J.C.Francken and J.van der Waal.

Vacuum (GB), Vol. 10, No. 1-2, 22-6 (Feb.-April, 1960).

The omegatron, a small mass spectrometer, was used to analyse the residual gas in television picture tubes. First the principle of operation of the omegatron is briefly recalled, and a short description of the construction is given. This instrument is mounted in a side arm connected to the bulb of a television tube, together with an ionization gauge and the whole assembly is pumped simultaneously. Both completed tubes and partly processed bulbs were prepared in this way. The residual gas after seal-off was analysed at different stages of processing, i.e. before and after flashing the getter, after drawing current with the ionization gauge and during shelf-life. The gas content after seal-off mainly consisted of hydrogen, nitrogen and methane. Generally in the bulb blanks hydrogen was the main gas whereas in completed tubes nitrogen had the higher pressure. In all cases small traces of H_2O, CO and CO_2 were found. All these gases disappeared almost completely after the getter had been flashed, but this operation produced an appreciable amount of hydrocarbons and some argon. Drawing current with the ionization gauge or with the electron gun of a completed tube resulted in a break-down and a subsequent adsorption of the hydrocarbons. On shelf-life these gases were partly desorbed. Scanning the screens resulted in a very rapid decrease in pressure of the hydrocarbons.

18493 CLEAN SURFACES AND SORPTION OF GASES.

A.Nasini, F.Ricca and G.Saini.

Vacuum (GB), Vol. 10, No. 1-2, 68-74 (Feb.-April, 1960).

Quotes the information obtained about the existence of: (a) various types of atoms on the metal surface, characterized by different sorption properties; (b) different coefficients of surface diffusion for the different crystal faces; (c) different states of the gas adsorbed on the metal. Concerning this latter point, useful information can be obtained from infrared spectroscopy of the adsorbed molecules. This complex picture of the observed phenomena is confirmed by results for the adsorption of nitrogen and carbon monoxide on tungsten. The technique used to measure the velocity of adsorption, based on the flow of gas through a capillary of known conductance, is similar to that used in the field of getters; the adsorbent is a tungsten lamina having a thickness of 0.0025 cm and a surface area of 27.5 cm^2; the measurements were carried out in the pressure range of 10^{-7} to 10^{-8} torr, and in the temperature interval between 90^0 and 480^0K. A problem of particular interest arises from the immeasurably low temperature coefficients and from the fact that the velocity of adsorption is initially independent of the surface coverage. The theoretical hypotheses put forward concerning this problem are briefly examined. The correct interpretation of such complex surface phenomena seems to be necessary even for the study of gas sorption by evaporated metal films.

18494 MEASUREMENT OF GAS EVOLUTION AND ABSORPTION FROM MATERIALS USED IN VACUUM TUBES.

K.Hashimoto, H.Iwayanagi and H.Fukushima.

Vacuum (GB), Vol. 10, No. 1-2, 92-9 (Feb.-April, 1960).

As a first step of their study on the gas-evolution from materials used in vacuum tubes, the authors took up three methods of measuring in common use, namely, the gas accumulation method, the gas flow (differential Pirani gauge) method, and the flowmeter method. While reviewing the principles of these methods, their sensitivities in relation to various gases are discussed, and mention is made of difficulties in experimenting with low pressure gases, especially the outgas from the glass wall and other parts of the vacuum system as well as the reaction between the sample material and the gases evolved from it. On the basis of the experimental results, the authors developed the gas evolution and adsorption gauges on the gas flow method, which record the measurement automatically. Some examples of the actual measurement of outgas characteristics of metal plates are given in this report. The characteristics of the gas absorption of titanium has many interesting problems and it suggests useful applications in the field of the vacuum tube production. The writers also carried out the experiment for studying the gas absorption rate of titanium for such gases as nitrogen, oxygen, carbon monoxide and carbon dioxide, at various temperatures. The pressure of the gas sealed in a vessel and contacted with the titanium surface decreased exponentially with time in the pressure range of this experiment, and it was then concluded that the absorption speed is nearly constant. From its dependence, the activation energies of absorption for these gases were calculated. Moreover, some interesting phenomena were found, such as the hysteresis effect of gas absorption and the jump of speed which occurred abruptly in the process of the carbon dioxide absorption.

VIBRATIONS . ELASTIC WAVES

(See also Shock Waves)

18495 REDUCTION OF THE RESPONSE TO VIBRATION OF STRUCTURES POSSESSING FINITE MECHANICAL IMPEDANCE. J.C.Snowdon.
J, Acoust. Soc. Amer., Vol. 33, No. 11, 1466-75 (Nov., 1961).

Expressions were derived from which the isolation provided by a simple mounting system when supported by any nonrigid foundation may be determined, if the mechanical impedance of the foundation is known. As an example, the mechanical impedance of a damped beam at its midpoint was employed to simulate the behaviour of such a foundation. Knowledge of the dynamic mechanical properties of natural rubber and a high-damping synthetic rubber has enabled the behaviour of antivibration mountings to be described realistically. If the ratio of the mass of the mounted item to the mass of the foundation is large, the isolation afforded by a mounting is found to be much less than that predicted by its transmissibility curve, which relates to an ideally rigid foundation. It is shown, however, that the isolation provided by a mounting can be increased significantly at high frequencies if an additional mass is employed to load the foundation, the greatest isolation then being provided by a low-damping rubber such as natural rubber. Damping of the foundation is found to have little influence upon the overall level of the isolation afforded by the mounting system.

18496 VIBRATIONS OF CROSS-STIFFENED AND SANDWICH PLATES WITH APPLICATION TO UNDERWATER SOUND RADIATORS. J.E.Greenspon.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1485-97 (Nov., 1961).

A simplified theory is presented for obtaining the frequencies, deflections, and stresses in cross-stiffened and sandwich plates under dynamic loading. Formulae are derived giving the effect of the water on the natural frequency and the approximate Q of the plate. The application of resonant plates as underwater sound radiators is discussed, and procedures for designing such radiators

18497 DAMPING WITHOUT INFLUENCE ON FREQUENCY. A.Bloch.
Nature (GB), Vol. 191, 1086-7 (Sept. 9, 1961).

Reformulation of conditions of damped oscillation without influence on frequency of gyroscopic systems (Abstr. 10462 of 1961), which can be extended to systems (not necessarily gyroscopic) with more than one degree of freedom. This is exemplified by a dynamic system consisting of a mass and a spring which both are subject to damping. J.K.Skwirzynski

18498 EFFECT OF DAMPING ON THE NATURAL FREQUENCIES OF LINEAR DYNAMIC SYSTEMS.
T.K.Caughey and M.E.J.O'Kelly.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1458-61 (Nov., 1961).

An analysis is presented of the effect of weak damping on the natural frequencies of linear dynamic systems. It is shown that highest natural frequency is always decreased by damping, but th lower natural frequencies may either increase or decrease, depe ing on the form of the damping matrix.

18499 DYNAMICS OF ELASTOPLASTIC SHELLS AND PLATES. É.I.Grigolyuk.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 6, 1317-20 (June 11, 1961). In Russian.

For abstract, see Abstr. 15989 of 1961. [English translation Soviet Physics—Doklady (USA), Vol. 6, No. 6, 515-18 (Dec., 1961)

18500 CALIBRATION OF VIBRATION PICKUPS AT LARGE AMPLITUDES. E.Jones, S.Edelman and K.S.Sizemo
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1462-6 (Nov., 1961).

Axial resonances of long rods and tubes were used to genera motion for accurate calibration of vibration pickups over the frequency range from below 1 to above 20 kc/s at acceleration levels up to 12 000 g. The resonators were driven by an electromagnetic shaker at low frequencies and by a piezoelectric ceram stack shaker at high frequencies. Vibration amplitude was measu optically by means of a microscope using stroboscopic light and means of the interference fringe disappearance technique. Adequ overlap between the two methods was achieved by going up to the 60th disappearance of the fringes. A simple, direct measuremen the phase angle between the pickup signal and the motion is described. Construction details of a small, light pickup which is unaffected by the high acceleration levels are given.

18501 NONLINEAR RESPONSE OF A SIMPLE CLAMPED PANEL. P.W.Smith, Jr, C.I.Malme and C.M.Gogos.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1476-82 (Nov., 1961).

Measurements are reported of some characteristics of the response of a simple panel to a steady periodic sound pressure intense enough to cause nonlinearity in the response. The panel i a 2 in. wide, thin aluminium strip, clamped at its ends with the cl faces 12 in. apart, and left free on its edges. Attention is focuse principally on the fundamental resonance point, which occurred a frequencies as large as twice the low-level resonance frequencie Measurements of the frequency and strain at resonance, under various levels of excitation, are compared with predictions from simple one-mode nonlinear dynamic equation. For good agreeme it is found necessary to include not only a nonlinear stiffness but also a nonlinear damping term. Theoretical predictions of the no linear stiffness from the physical characteristics of the panel are error by a factor of 4.7 when based on an assumed mode shape fo transverse deflection which is identical with the linear charact istic function of a clamped-clamped beam.

18502 FREQUENCY OF EDGE MODE OF ISOTROPIC THIN RECTANGULAR PLATE, CIRCULAR DISK AND ROD. M.Onoe.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1627 (Nov., 1961).

The frequency of the edge mode, which is closely associated with the complex branches of the dispersion equation, was approx mated by taking only the complex branches into account. The frequencies for a thin rectangular plate, a circular disk and a rod were evaluated as functions of Poisson's ratio and compared with values observed by various investigators.

18503 EDGE MODE OF THIN RECTANGULAR PLATE OF BARIUM TITANATE. M.Onoe and Y.H.Pao.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1628 (Nov., 1961).

The frequency spectrum of a thin rectangular plate of barium titanate ceramics was measured as a function of length/width rat with particular emphasis on a special mode of contour vibration, named edge mode.

18505 AXIAL-SHEAR VIBRATIONS OF AN INFINITELY LO COMPOSITE CIRCULAR CYLINDER.
J.H.Baltrukonis, W.G.Gottenberg and R.N.Schreiner.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1447-57 (Nov., 1961).

Exact general solutions of the three dimensional elasticity equations of motion in polar cylindrical coordinates are written f axisymmetric and antisymmetric axial-shear vibrations. The frequency equation follows immediately from the boundary condit for the problem of the infinitely long composite cylinder with two concentric circular-cylindrical layers which are perfectly bonded their interface. The branches of the frequency equation are plott and analysed. The conditions are pointed out under which it is

ible to obtain reasonably accurate estimates of the natural
ıencies by assuming that the motions of the casing and core are
upled.

A PRACTICAL METHOD OF VISUALIZING TIME OR SPACE
ΓRIBUTIONS OF NOISE OR VIBRATION. See Abstr. 18537

.8506 EXPERIMENTAL STUDY OF THE EFFECT OF SURFACE QUALITY ON THE DAMPING OF SURFACE
ΈS [IN SOLIDS]. N.S.Bÿkov and Yu.G.Shneider.
st. Zh. (USSR), Vol. 6, No. 4, 501-3 (1960). In Russian.
lish translation in: Soviet Physics—Acoustics (USA), Vol. 6,
4, 500-2 (April-June, 1961).

8507 ATTENUATION OF RAYLEIGH WAVES IN AN ELASTIC LAYER ABOVE A HALF-SPACE. N.N.Egorov.
st. Zh. (USSR), Vol. 7, No. 3, 378-80 (1961). In Russian.
[English translation in: Soviet Physics—Acoustics (USA)].

.8504 THE FUNDAMENTAL FREQUENCY OF A VIBRATING MEMBRANE: EVALUATIONS BY DEFAULT AND THE
IMUM PRINCIPLE. J.Hersch.
ngew. Math. Phys. (Switzerland), Vol. 11, No. 5, 387-413
t. 25, 1960). In French.

A simple Payne—Weinberger's method [Journal of the Society of
strial and Applied Mathematics (USA), Vol. 5, 171-82 (1957)]
rst used to obtain lower bounds for the first eigenvalue of a
ıbrane by comparison with the Rayleigh principle for homogene-
strings. A generalization of this idea to auxiliary non-
ogeneous strings leads to a maximum principle (of which the
a—Pólya inequality is a special case); in another form, it was
ntially known (although with some unnecessary restrictive
theses) to Protter [Tech. Report No. 8, AFOSR, Univ. of
fornia, Berkeley (1958)]. Some applications of the principle to
calculation of rather sharp lower bounds are indicated, as well
n intuitive physical interpretation (in terms of variation of
ses and constraints). It is valid in three dimensions, and its
nsion to Schrödinger's equation is indicated.

ACOUSTICS

18508 RADIATION OF SOUND BY PLATES AND SHELLS IN WATER. L.M.Lyamshev and S.N.Rudakov.
st. Zh. (USSR), Vol. 7, No. 3, 380-3 (1961). In Russian.
[English translation in: Soviet Physics—Acoustics (USA)].

18509 RADIATION OF SOUND IN A LIQUID WITH CAVITATION PRESENT. L.D.Rozenberg and M.G.Sirotyuk.
st. Zh. (USSR), Vol. 6, No. 4, 478-81 (1960). In Russian.

It is experimentally demonstrated that at a frequency of
c/s, the radiation impedance of a sinusoidally oscillating radia-
as measured on the electrical side, begins to fall off sharply at
instant that cavitation sets in. With a further increase in part-
velocity and corresponding growth in cavitation, the specific
ation impedance attains a value of 0.3 $\rho_0 c$ and then becomes
ilized. The radiated acoustic intensity at first increases in pro-
ion to the square of the radiator particle velocity, then its
th slackens and ceases altogether at a level of 1.5 W/cm^2. With
ncrease in particle velocity above 25 cm/sec radiation intensity
again begins to increase in proportion to the square of the part-
velocity, but with one third the previous slope. [English trans-
n in: Soviet Physics—Acoustics (USA), Vol. 6, No. 4, 477-9
il-June, 1961)].

18510 A POWERFUL LOW-FREQUENCY ACOUSTIC SIREN. V.V.Vyal'tsev and V.G.Khorguani.
st. Zh. (USSR), Vol. 7, No. 3, 377-8 (1961). In Russian.
lish translation in: Soviet Physics—Acoustics (USA).

18511 ELECTROACOUSTIC SELF-MAINTENANCE OF RESONANT TUBES. APPLICATION TO THE STUDY OF
JPLING WITH A PASSIVE TUBE OF ADJUSTABLE LENGTH.
ousseau.
. Phys. (France), Vol. 6, No. 1-2, 125-81 (Jan.-Feb., 1961).
rench.

Summary of published theory on maintenance and damping of oscillations in tubes, with particular reference to the present work on plane standing waves (generated from spherical waves of electromechanical origin outside the tube). Experimental procedure is given in great detail, leading to results showing the dependence of coupling between tubes on their relative dimensions and separations. A theoretical explanation and an electrical analogue are proposed.

V.J.Hammond

EXCITATION OF ACOUSTIC WAVES BY INTERACTION BETWEEN CHARGED PARTICLES AND NEUTRAL MOLECULES IN A DISCHARGE TUBE. See Abstr. 18783

18512 RADIATION FROM CIRCULAR PISTONS OF ELLIPTICAL PROFILE. A.Silbiger.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1515-22 (Nov., 1961).

While extensive information is available on flat pistons and on spherical radiators, no data have been given for the intermediate case of convex circular pistons of elliptical profile. This paper presents information on the radiation loading and on the near and far field of such pistons. For the case of a free piston it is found that at small ka (where 2a is the diameter or major axis) the reactance decreases with increasing thickness (minor axis), while the resistance increases at small ka and decreases at large ka with increasing thickness. In the intermediate ka region, that is, when the wavelength in the fluid is of the order of magnitude of the dimensions of the piston, the dependence of the impedance on the thickness is more complicated. For the case of a piston in an infinite baffle the behaviour of the reactance is similar to that for the free pistons. The resistance however is independent of the thickness in the limit of small ka and decreases with increasing thickness at larger ka. The effect of flexure on the impedance is briefly considered for the case of the free piston.

18513 RADIATION OF WAVES BY SHELLS IN A SOUND-FIELD. V.I.Makarov and N.A.Fadeeva.
Akust. Zh. (USSR), Vol. 6, No. 2, 261-3 (1960). In Russian.

A photograph obtained by the shadow method of a steel cylindrical shell (end view) immersed in water or irradiated with ultrasound is shown in illustration of the authors' remarks. Interference phenomena inside and outside the "shell" are clearly observable. Those arising inside reveal a number of "caustics" from which the authors deduce the wavelengths and hence the velocities of sound in the liquid and in the steel cylindrical shell. The method proves useful in studying the sound-fields radiated by shells of complex form. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 257-8 (Oct.-Dec., 1960)].

A.B.Wood

18514 STEADY FORCES ARISING IN A SOUND FIELD. I.N.Kanevskii.
Akust. Zh. (USSR), Vol. 7, No. 1, 3-17 (1961). In Russian.

An "omnibus" paper collecting known data "which might give some notion concerning the physical picture of the origination and means of computing the various steady-state forces that appear in the interaction of a sound-field with objects situated in it". Amongst others, the following are mentioned: (1) Hydrodynamic forces including Bernoulli forces, Oseen and Goldstein corrections, viscous forces around non-spherical bodies. (2) Forces in the acoustic field including Bjerknes forces, Stokes forces with variable velocity, Oseen force connected with waveform distortion, radiation pressure, Rayleigh disc, acoustic wind. A list of fifty five references to published papers is given. [English translation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 1-10 (July-Sept., 1961)].

A.B.Wood

18515 MODEL STUDY OF THE FIELD OF A PULSE RADIATOR IN THE FIRST EFFECTIVE SHADOW ZONE OF AN UNDERWATER SOUND CHANNEL. I.I.Shmelev.
Akust. Zh. (USSR), Vol. 7, No. 1, 106-8 (1961). In Russian.

A comparison of experimental data with theory shows the extent to which the acoustic field may be calculated by making use of the theory of antiwaveguide propagation. Reference is made to previous papers for experimental techniques and preliminary results (see, for example Abstr. 245 of 1947; 19270 of 1960). [English translation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 86-7 (July-Sept., 1961)].

J.D.Rands

18516 CALCULATION OF THE COEFFICIENT OF AXIAL CONCENTRATION OF SOME DISCRETE RADIATOR–RECEIVER ARRAYS. R.V.Belyakov.
Akust. Zh. (USSR), Vol. 6, No. 4, 499-501 (1960). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 4, 498-500 (April-June, 1961).

18517 SAWTOOTH [SOUND] WAVES IN ELECTROLYTES. E.V.Romanenko.
Akust. Zh. (USSR), Vol. 6, No. 4, 508-9 (1960). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 4, 508-10 (April-June, 1961).

OBSERVATIONS OF IONIC SOUND WAVES IN PLASMAS. See Abstr. 18861

18518 INFLUENCE OF POSITION ON THE ACTION OF SPATIAL [SOUND] ABSORBERS. M.Abramchik and I.Maletskii.
Akust. Zh. (USSR), Vol. 6, No. 4, 494-5 (1960). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 4, 491-2 (April-June, 1961).

18519 LONG-RANGE SHALLOW-WATER TRANSMISSION. K.V.Mackenzie.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1505-14 (Nov., 1961).

Propagation losses are computed for 200 to 2000 c/s sound in 25 fathom water to ranges of 250 miles over different bottoms for a zero gradient (isospeed), and out to 50 miles for both a weak negative gradient and a strong negative gradient. The ray method is used, together with the assumption of random phase after the first bottom reflection. The resulting computed transmission loss anomalies exhibit a marked dependence on: (1) the ratio of source depth to wavelength; (2) the sound-speed gradients; (3) bottom reflection losses at small grazing angles. The bottom reflection losses are strongly dependent on the attenuation in the bottom. Some long-range experimental data are presented which show a quantitative agreement with the computed curves out to ranges of 40 miles.

18520 GRAIN-SIZE DISTRIBUTION IN METALS AND ITS INFLUENCE ON ULTRASONIC ATTENUATION MEASUREMENTS. E.P.Papadakis.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1616-21 (Nov., 1961).

A transformation was derived relating the number of spheres of a certain radius R per unit volume (the "volume distribution of spheres") to the number of circles smaller than a certain radius r per unit area (the "area distribution of circles") appearing on a plane cutting through the volume. The transformation was applied to several hypothetical grain-size distributions for polycrystalline metals to find the resulting hypothetical area distribution of grain images on photomicrographs. Comparison between hypothetical area distributions and experimentally found area distributions gave the following conditions that the true volume distribution of grains must meet: (1) It must be finite at R = 0; (2) it must have a nonzero decreasing tail for large values of R. The common assumption of a single grain diameter is insufficient to explain the experimental area distribution of grain images. The functions $N_V(R) = R^n \exp(-kR)$ and $N_V(R) = \exp[-(\ln R/R_0)^2/2\sigma_V^2]$ were judged plausible for the volume distribution function of grains, and a correction was computed for the attenuation formulae for Rayleigh scattering of ultrasonic waves in polycrystalline metals by taking averages of R^6 and R^3 over these functions.

18521 LOW-FREQUENCY SOUND PROPAGATION IN GASES. F.A.Smith and W.Tempest.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1626-7 (Nov., 1961).

A resonance-tube method was developed for the measurement of sound absorption and velocity in gases at frequency to pressure ratios from 36 to 3800 c/s atm. Measurements in oxygen at 30°C show velocity dispersion and excess absorption due to relaxation of the vibrational mode of the oxygen molecule with a relaxation time of $3.2 \pm 0.3 \times 10^{-3}$ sec. The results are in agreement with those obtained by Knotzel and Knotzel (1948).

18522 REFLECTION OF SOUND FROM A MOVING THIN PLATE. L.M.Lyamshev.
Akust. Zh. (USSR), Vol. 6, No. 4, 505-7 (1960). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 4, 505-7 (April-June, 1961).

18523 FLUCTUATIONS IN HYDROACOUSTIC PULSE SIGN
ON REFLECTION FROM A WATER SURFACE ON
WHICH WAVES ARE PRESENT. G.E.Smirnov and O.S.Tonakar
Akust. Zh. (USSR), Vol. 6, No. 4, 482-90 (1960). In Russian.

The reflection of hydroacoustic pulse signals from a wavy
surface was studied experimentally. Measurements were made
isothermal conditions on a model in a hydroacoustic tank with a
regular wave and under natural conditions in a water reservoir
the presence of wind waves. In conjunction with the recording c
reflected signals the roughness of the water surface was also re
corded. Rigidly secured radiating and receiving systems were
The frequency range of the simulation measurements was from
200 kc/s; the natural measurements were performed at frequen
from 5 to 25 kc/s. A distinct correlation was found to exist bet
the signal and waviness of the water surface. Amplitude coeffic
of variation and the magnitude of phase difference fluctuations w
obtained for the reflected signals for various values of the surfa
roughness coefficient of the water. [English translation in: Sov
Physics—Acoustics (USA), Vol. 6, No. 4, 480-7 (April-June, 196

18524 ABSORPTION OF SOUND REFLECTED FROM THE PLANE SURFACE OF A SOLID.
R.Ya.Kucherov and T.S.Tsulaya.
Akust. Zh. (USSR), Vol. 7, No. 1, 96-7 (1961). In Russian.

In investigating the reflection of sound of high frequency,
propagated in a rarefied gas, it may be necessary in considerin
reflection at a solid boundary to include higher order terms tha
is customary in dealing e.g. with reflection in air from a solid
wall (Rayleigh-sound is quoted here). The parameter l/λ is
important in the case now considered (l is mean free path of mo
cules and λ is the acoustic wavelength). Expressions are deriv
in the cases where the solid wall is a perfect heat conductor or
perfect heat insulator. The corrections considered appear only
in terms higher than the first order. [English translation in:
Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 76-7 (July-Sept.
1961)]. A.B.V

18525 BOTTOM REVERBERATION FOR 530 AND 1030 c/
SOUND IN DEEP WATER. K.V.Mackenzie.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1498-1504 (Nov., 1961).

Bottom reverberation measurements were made during
September, 1954, with 530 and 1030 c/s sound in 2100 fathom wa
near San Diego for ping durations of 0.1, 0.25, 0.5, 1.0 and 2.0 s
with omnidirectional sources and receivers. The data were
analysed by assuming that the returned sound consisted of both
specularly and nonspecularly reflected sound, analogous to the
regular and diffuse reflected light from Bristol board. At norm
incidence the losses on reflection for the 530 and 1030 c/s soun
were 19.5 ± 2.5 dB and 15.4 ± 1.7 dB, respectively. The other
sound returning from the bottom as reverberation was assumed
be due to nonspecular reflections obeying Lambert's law of diffu
reflection. The reverberation level due to the nonspecular
reflections was then analysed to obtain the scattering constant μ
of the bottom. A value of $10 \log\mu = -27$ dB was obtained for bot
the 530 and 1030 c/s sound. The curves computed for a sine-squared dependence fit the data for grazing angles from 90^0 to 3
A comparison with published values of other investigators indic
that for clays, muds, or fine grained sands there appears to be
significant frequency dependence over a range of seven octaves.

THE DIFFRACTION OF A SCALAR WAVE BY A SMALL CIRCULAR APERTURE. See Abstr. 18613

18526 SCIENCE AND MUSIC.
W.H.George.
Sci. Progr. (GB), Vol. 49, 409-26 (July, 1961).

A survey of some recent developments in the subject, with
particular emphasis on the need to include the human observer.
Modern electro-acoustical developments have shown that classi
ideas on pitch, loudness, and tone colour are inadequate. There
is no single characteristic acoustic spectrum for a given music
instrument, and electronically synthesized sounds are always
recognizably different from natural sounds to a keen listener.
is believed that the growth and decay and variations with time a
fundamentally important, since human beings have an unexplain
sensitivity to change. G.M.B

8527 PHONETIC TYPEWRITER III.
H.F.Olson and H.Belar.
coust. Soc. Amer., Vol. 33, No. 11, 1610-15 (Nov., 1961).
Many new improvements over earlier models of the phonetic
writer have resulted from developments which provide means
reducing the number of different displays obtained for the same
able without unduly increasing the complexity of the machine.
erms of the ultimate machine which should provide means for
lling 1000 to 2000 syllables, model III with a maximum capacity
oout 100 syllables is still a rudimentary phonetic typewriter.
ever, the model III provides a complete system from the sounds
peech input to the typed-page output, which is of great value in
re research in speech analysis. Specifically, the subjects
sidered in this paper are as follows: form of the typed
sentation, construction, circuits, syllable memory, typing console,
lling memory, choice of vocabulary, procedure for setting up the
nory, and codes obtained.

struments and Measurements

8528 A WIDEBAND VELOCITY MICROPHONE.
B.S.Zalivadnyi.
st. Zh. (USSR), Vol. 7, No. 1, 94-6 (1961). In Russian.
The basic principle utilized in this microphone is as follows:
ı the passage of a sound wave through an ion cloud created in
the ions making up this cloud begin to oscillate, their particle
ocity being equal to the particle velocity of the molecules of the
lium even in the case of heavy ions. In the microphone now
cribed the ion emitter is a porcelain rod surrounded by a
inum heater, and having a nearby gauze "collector" in the grid
cuit of a valve amplifier. In the frequency range 500 to 2500 c/s
output e.m.f. is of the order 5 to 10 millivolts cm^{-1} sec^{-1}
ticle velocity. [English translation in: Soviet Physics—Acoustics
A), Vol. 7, No. 1, 74-6 (July-Sept., 1961)]. A.B.Wood

8529 DeFOREST'S "DIFFRACTION MICROPHONE" — OPTICAL DETECTION OF SOUND IN AIR. R.C.Levine.
coust. Soc. Amer., Vol. 33, No. 11, 1625-6 (Nov., 1961).
A theoretical analysis of a microphone which optically detects
changes in air density or index of refraction due to sound waves
DeForest 1924). A light ray penetrates a thermal gradient
ne air, and predicted deflection of the ray is approximately
10^{-5} cm per microbar sound pressure for a 300°K temperature
nge in a path length of 1 cm.

18530 APPLICATION OF BARIUM TITANATE PIEZO-CERAMIC TRANSDUCERS FOR STUDYING ULTRA-
ND IN DIFFRACTION-TYPE LIGHT MODULATORS.
ıdrianova, Yu.V.Popov and B.A.Rotenberg.
st. Zh. (USSR), Vol. 6, No. 2, 162-70 (1960). In Russian.
A study was made of the use of barium titanate ceramic trans-
ers for propagating ultrasound in a xylene bath for the purpose
iffraction-type light modulation. They are found to be efficient
ulators between 3 and 15 Mc/s, using harmonic operation for the
er frequencies, and to have better frequency characteristics for
purpose than quartz. 3-4 days after polarization, these
racteristics do not alter appreciably for at least a year.
glish translation in: Soviet Physics—Acoustics (USA), Vol. 6,
2, 162-9 (Oct.-Dec., 1960)]. L.Mackinnon

18531 INTERFEROMETER MEASUREMENT OF ULTRASONIC ABSORPTION IN GASES.
Perepechko and V.F.Yakovlev.
st. Zh. (USSR), Vol. 7, No. 1, 101-2 (1961). In Russian.
The variation of the potential of a quartz crystal in an ultra-
ic interferometer is used to calculate the absorption in a gas
er different conditions. Measurements for argon and helium
ween 0.5 and 0.05 atm) agree with accepted results. [English
ıslation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 81-2
y-Sept., 1961)]. V.J.Hammond

18532 AN EXPERIMENTAL CONTRIBUTION TO THE INVESTIGATION OF AN ULTRASONIC FIELD BY MEANS OF
OPTICAL METHOD. A.Barone and F.Fanti.
erca sci. (Italy), Vol. 30, No. 12, 2353-62 (Suppl. Dec., 1960).
alian.

By means of an optical method, the distribution of ultrasonic intensity on a plane normal to the direction of propagation of an ultrasonic beam generated in water by a circular quartz plate at 4 Mc/s was determined. The method consists in the study of the deformation of the free fluid surface brought about by the radiation pressure.

18533 ON PREFERRED FREQUENCIES FOR ACOUSTICAL MEASUREMENT. P.Wang.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1625 (Nov., 1961).

A new table of frequencies is suggested to American Standard Association as amendment to S1.6-1960.

18534 OPTIMUM HYDROPHONE DESIGN FOR LOW FREQUENCIES. T.F.Hueter and P.H.Moose.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1628-9 (Nov., 1961).

In a recent paper (Abstr. 8179 of 1961), Kendig emphasizes the importance of efficiency in the design of an optimum hydrophone. However, in most applications, the threshold of signals that may be measured is determined essentially by the self-noise of the associated preamplifier. Therefore, in practice, the highest sensitivity hydrophone will result in the best signal-to-noise ratio. Because of the availability of high-grade ceramics and high-impedance preamplifiers, the significant problem facing the designer is which physical configuration to employ. The comparative equations given in Kendig's paper may be misleading in the selection of the optimum physical shape, which, as demonstrated by a practical example, should be dependent on consideration of sensitivity and impedance.

18535 PROCEDURE FOR CALCULATING LOUDNESS: MARK VI. S.S.Stevens.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1577-85 (Nov., 1961).

In order to improve the procedure for calculating the loudness of a complex sound, two changes have been made. (1) The equal loudness contours for bands of noise in a diffuse field have been approximated by straight lines in a log—log plot. (2) The spacing of the contours has been altered to reflect the nonlinear growth that takes place in the loudness level of bands of noise when their width exceeds the critical bandwidth. The basic formula for the addition of loudness across frequency remains the same: the total loudness S_t is given by $S_t = S_m + F(\Sigma S - S_m)$, where S_m is the loudest band and F has the values 0.3, 0.2, and 0.15 for octave, half-octave, and third-octave bands. The revised procedure has the advantages that it can be described more easily and it agrees better with the available measurements on loudness level.

18536 ROLE OF EQUIVALENT NOISE PRESSURE AND SENSITIVITY IN DETERMINING SIGNAL-TO-NOISE RATIO. P.M.Kendig.
J. Acoust. Soc. Amer., Vol. 33, No. 11, 1629-30 (Nov., 1961).

The relative importance of the receiving sensitivity, impedance, efficiency, and equivalent noise pressure of a hydrophone in determining signal-to-noise ratio is discussed. It is concluded that even when the threshold is determined by the self-noise of the preamplifier, it is the equivalent noise pressure, or rather the efficiency, that ultimately determines the signal-to-noise ratio, provided the hydrophone impedance is taken into account.

Noise . Architectural Acoustics

18537 A PRACTICAL METHOD OF VISUALIZING TIME OR SPACE DISTRIBUTIONS OF NOISE OR VIBRATION.
I.I.Klyukin.
Akust. Zh. (USSR), Vol. 6, No. 2, 261 (1960). In Russian.

As a means of visualizing sound spectra of noise e.g. from machinery, a modification in the use of an acoustic spectrometer of the third-octave or half-octave type has been introduced. In essence the modifications are constituted such that the signal from the spectrometer amplifier is not fed to the deflection plates of the cathode-ray tube but to the electrode that controls the brightness. At the same time a uniform projection of photosensitive film is inserted in front of the screen of the tube in a direction perpendicular to the frequency axis. Spectrograms are reproduced: (1) signals from a white-noise generator, (2) the starting and stopping of a Diesel engine; and (3) noises escaping from points opposite the "hatches" to a machine shop. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 254-6 (Oct.-Dec., 1960)]. A.B.Wood

18538 USE OF DELTA FUNCTION FOR THE CORRELATIONS OF PRESSURE FIELDS. G.Maidanik.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1598-1606 (Nov., 1961).

Using essentially the methods of Lyon (Abstr. 4256 of 1956) and Dyer (Abstr. 9319 of 1959) the response of a one-dimensional, simply supported elastic system (such as a string or a bar) to random convecting force fields is calculated. The spatial as well as the time dependence of the correlation function of the force field are assumed to decay exponentially. The response is analysed as a function of the force-field parameters in relation to the dynamic characteristics of the system. Special attention is focused on the limiting case where the correlation function approaches the delta-function form in space or time or both. In this way a criterion is established for the validity of the delta function approximation for such problems.

18539 RESPONSE OF STRINGS TO MOVING NOISE FIELDS. G.Maidanik and R.H.Lyon.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1606-9 (Nov., 1961).

A re-examination of Lyon's experimental results (Abstr. 4256 of 1956) on turbulent excitation of strings is made in the light of new information on boundary-layer turbulence and on extended theoretical calculation. It is shown that the extended theory together with reasonable modifications in the parameters describing the turbulent flow lead to better agreement between experiment and theory.

18540 MEASUREMENT OF THE DYNAMIC PARAMETERS OF SOUND INSULATING MATERIALS.

V.I.Zaborov and G.S.Rosin.

Akust. Zh. (USSR), Vol. 7, No. 1, 92-4 (1961). In Russian.

At frequencies sufficiently far removed from resonance, the mechanical impedance of a material specimen (of sound insulating material) differs but slightly from the impedance obtained when losses are not neglected. A method is outlined in which the specimen is loaded by a known mass, using an electrodynamic accelerator which has a driving coil and a balancing coil fed by a.c. At regions far off resonance the phase shift is nearly 90° and the mechanical impedance is almost equal to its reactive component. Figures are given which show the frequency characteristics of the dynamic elastic moduli of some sound insulating materials, e.g. fibreboard, sponge-rubber, felt matting, mineral and slag wool, and plastic foam. [English translation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 72-4 (July-Sept., 1961)]. A.B.Wood

18541 THE ACOUSTIC IMPEDANCE OF THIN LAYERS OF POROUS MATERIAL.

M.A.Ferrero and G.G.Sacerdote.

Acustica (Internat.), Vol. 10, No. 5-6, 336-9 (1960).

The behaviour of the real component of the acoustic impedance of a thin layer of porous material adhering to a rigid wall is studied: this component increases greatly when the layer becomes very thin.

18542 LABORATORY MEASUREMENTS OF SOUND TRANSMISSION THROUGH SUSPENDED CEILING SYSTEMS.

R.N.Hamme.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1523-30 (Nov., 1961).

A description of a laboratory unit for the measurement of sound transmission through suspended acoustical ceilings under field conditions of erection over part-high partitions. The results of exploratory measurements are reviewed for a wide range of the dimensional and acoustical parameters of the ceiling—plenum system. Consideration is extended to the ceiling—partition system and to the importance of an accurate simulation of field conditions of erection for the testing of all elements, individually and interacting, in the ceiling—plenum—partition system. The compatibility of this approach with conventional test methods is suggested.

18543 PROBLEMS OF FIELD MEASUREMENT OF TRANSMISSION LOSS AS ILLUSTRATED BY DATA ON LIGHTWEIGHT PARTITIONS USED IN MUSIC BUILDINGS.

R.N.Lane and E.E.Mikeska.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1531-5 (Nov., 1961).

Field measurements of airborne sound transmission loss involve several practical difficulties and limitations as compared to the laboratory standard test procedures for such measurements. Data from field measurements are valuable to architects and acoustical consultants, in spite of these limitations. A workable procedure for field measurements is described, along with a discussion of the difficulties. Measured transmission loss dat are presented for double plaster walls on cork isolation, double plaster walls on concrete slabs, double concrete block walls, double brick walls, single concrete block walls, and a floor slab with resiliently suspended plaster ceiling.

OPTICS . PHOTOMETRY

18544 PROGRESS IN OPTICS. VOLUME I. Edited by E.Wolf.

Amsterdam: North-Holland Publishing Company (1961) 342 pp.

The first volume of a series devoted to review articles on current researches in optics and in related fields. This issue contains eight articles, each of which concludes with a series of references. There are adequate author and subject indexes. Abstracts of the papers follow.

18545 THE MODERN DEVELOPMENT OF HAMILTONIAN OPTICS. R.J.Pegis.

"Progress in Optics, Vol. I", p. 3-29.

Summary of the theory of the characteristic function (eikona following mainly the methods of Smith. The general forms of the aberrations of different orders are obtained, with dependence on object and stop positions, but there are no explicit aberration formulae. 10 references. W.T.Welf

18546 WAVE OPTICS AND GEOMETRICAL OPTICS IN OPTICAL DESIGN. K.Miyamoto.

"Progress in Optics, Vol. I", p. 33-66.

Review of comparisons of image formation according to scalar wave theory and geometrical theory, for point and periodi objects. Photographic comparisons of aberrated point images a corresponding spot diagrams are given and there are some new computations of response function for different primary aberrati and square exit pupil. Criteria of image quality based on statist parameters of spot diagrams are surveyed. 58 references. W.T.Wel

18547 THE INTENSITY DISTRIBUTION AND TOTAL ILLUMINATION OF ABERRATION-FREE DIFFRACTION IMAGES. R.Barakat.

"Progress in Optics, Vol. I", p. 69-108.

Survey of scalar wave theory calculations of point images w different pupil functions, e.g. semi-circular pupil, apodized pupi A few cases of extended non-periodic objects are included and there are several photographs of diffraction images. Review of recent attempts at vector theories as improved approximations the strict electromagnetic theory. 104 references, including sor little-known original references. W.T.Welf

18548 LIGHT AND INFORMATION. [TEXT OF THE 1951 RITCHIE LECTURE, UNIVERSITY OF EDINBURGH, NOT PREVIOUSLY PUBLISHED]. D.Gabor.

"Progress in Optics, Vol. I", p. 109-53.

A philosophical discussion of the application of information-theoretic ideas to optics. The resolution of two ingenious parad is used to show that the postulate of a finite information capacity an optical channel suggests the quantization of light energy. An expression is obtained for the number of distinguishable states c light beam which can be attenuated by filters. 22 references. W.T.Welf

18549 ON BASIC ANALOGIES AND PRINCIPAL DIFFEREN BETWEEN OPTICAL AND ELECTRONIC INFORMA

H.Wolter.

"Progress in Optics, Vol. I", p. 155-210.

The analogies discussed are those between multilayers and four-terminal networks, between light and wireless waves in res of certain diffraction effects and between optical image formatio and communication theory in the use of Fourier transform techn noting here the fundamental distinction between spatial and temp frequencies. Limitations of the analogies are made clear by practical examples. 49 references. W.T.Welf

18550 INTERFERENCE COLOUR.
H.Kubota.
ogress in Optics, Vol. I'', p. 211-51.
Review of computations of the colour coordinates in the CIE
tem of interference colours of one- and two-layer anti-reflection
tings, some multilayer films and certain polarization and
raction colours. Some discussion of sensitive tints.
references. W.T.Welford

18551 DYNAMIC CHARACTERISTICS OF VISUAL PROCESSES. A.Fiorentini.
ogress in Optics, Vol. I'', p. 253-88.
Review of work on acuity of visual perception, considering
ticularly effects of involuntary eye movements and experiments
n stabilized retinal images. Effects of intermittent illumination
problems of contour perception are briefly discussed.
W.T.Welford

18552 MODERN ALIGNMENT DEVICES.
A.C.S.Van Heel.
ogress in Optics, Vol. I'', p. 289-329.
Review of work mainly by the author and his co-workers on
-image-forming alignment systems, in which a straight line is
duced as the axis of a diffraction pattern in space. 26 references.
W.T.Welford

18553 SPECTRAL ANALYSIS. TYPES OF INTEGRALS AND CONVOLUTIONS. P.M.Duffieux.
. Opt. (France), Vol. 39, No. 11, 491-504 (Nov., 1960). In French.
General discussion of the role of Fourier transform techniques
he study of optics and of physical processes involving information
nsfer. Functions representing source, channel and receptor are
ned together with their transforms and the different possible
des of combining these by products and convolution integrals are
ssified according to their physical meanings. W.T.Welford

18554 PHASE OPERATORS IN RADIATION THEORY.
F.Károlyházy.
a. phys. Hungar., Vol. 12, No. 4, 321-8 (1960). In German.
Let the vector potential A be Fourier analysed in the usual
nner:

$$A = \sum_{\lambda}\{q_{\lambda}(t)A_{\lambda}(r) + c.c.\}$$

phase operators ϕ are then defined by the decomposition $g = \phi C$
the conditions

$$\dot{C} = \frac{i}{\hbar}[H,C] = 0; \quad \ddot{\phi} = \frac{i}{\hbar}\; H,\frac{i}{\hbar}[H,\phi] = -\nu^{2}\phi$$

corresponding commutation relations are

$$\phi_{\lambda}N_{\lambda} - N_{\lambda}\phi_{\lambda} = \phi_{\lambda}$$

oton coherence problems may be conveniently discussed with this
malism. In particular it can be shown that phase differences and
al photon number are simultaneously observable for the radiation
tern of two interfering aerials. T.Erber

18555 INCOHERENT SOURCE WITH AN ARBITRARILY NARROW POWER SPECTRUM. T.J.Skinner.
Opt. Soc. Amer., Vol. 51, No. 8, 909-10 (Aug., 1961).
A scalar disturbance is constructed analytically for which the
quency range can be arbitrarily narrow; the mutual coherence
ction between any two separated points is zero, showing that
owledge of the power spectrum gives no information about the
ree of coherence". W.T.Welford

18556 GENERATION OF OPTICAL HARMONICS.
P.A.Franken, A.E.Hill, C.W.Peters and G.Weinreich.
s. Rev. Letters (USA), Vol. 7, No. 4, 118-19 (Aug. 15, 1961).
A brief description of the analysis of generation of optical harm-
cs using intense monochromatic light beams having electric fields
0^{5} V cm^{-1} is presented, together with descriptions of experi-
nts in which the second harmonic (at ~ 3472 A) was observed by
jecting an intense beam of 6943 A light through crystalline
rtz. The source used for producing the intense beam is a
sed ruby optical maser. S.A Ahern

18557 ON THE INTERFERENCE OF PHOTONS.
T.Neugebauer.
ta phys. Hungar., Vol. 12, No. 3, 241-7 (1960). In German.
A review to explain that in the visible and the shortwave region the paradox exists that a light quantum appears only to interfere with itself whereas in the radio region, different photons can interfere. Further consideration of the mechanism of emission is required. It is shown that in molecules, atoms and atomic nuclei there is no phase relation between successive photons. In the case of a radio aerial, on the contrary, each photon must be related to the previous one. S.Tolansky

18558 A METHOD TO VERIFY EXPERIMENTALLY THAT THE SPEED OF LIGHT IS INDEPENDENT OF THE VELOCITY OF THE SOURCE. A.G.Baranov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 860-2 (March, 1961).
In Russian.

A laboratory experiment is suggested which can be employed to verify directly whether the speed of light is independent of the velocity of the source. The effect is of the first order in v/c. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 603-4 (Sept., 1961)].

18559 METHOD FOR MEASURING SMALL OPTICAL ANISOTROPY. S.N.Pen'kov.
Optika i Spektrosk. (USSR), Vol. 10, No. 6, 787-91 (June, 1961).
In Russian.

A photoelectric method for measuring small optical anisotropy is described, based on the separation from the total light-beam of a component proportional to the phase difference δ. The method provides a large signal-to-noise ratio and permits reliable measurements of small values of δ in those cases where the anisotropy cannot be determined by the method of visual compensation. The application of the method is illustrated by several examples. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 6, 416-18 (June, 1961)].

18560 PHOTOGRAPHIC PHOTOMETRY OF LARGE AREAS.
E.Lau and G.Hess.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 11, 676-9 (1960). In German.

A method is described in which the photograph is taken through a raster. Typical applications to astronomy are shown.
R.W.Fish

18561 A NEW PHOTOMETRIC TECHNIQUE USING A VARIABLE SHUTTER DEVICE.
O.C.Jones and F.J.J.Clarke.
Nature (GB), Vol. 191, 1290 (Sept. 23, 1961).

A technique is described for measuring optical transmission by balancing the photocell output from two beams, one that has passed through the sample under examination and the other through a rotating shutter, the "open-to-shut" time ratio of which can be varied. The latter time ratio is a measure of transmission.
W.G.Jordan

GEOMETRICAL AND INSTRUMENTAL OPTICS SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

18562 CRITICAL DISCUSSION OF THE CONTRAST TRANSMISSION FUNCTION. G.Franke.
Optik (Germany), Vol. 18, No. 7, 320-5 (July, 1961). In German.

The contrast transmission (frequency response) functions of an optical system give a complete description of its quality. Nevertheless, this does not mean that graphical representation of the aberrations is superfluous, since only this information can give the expert a rapid appraisal of the state of correction of the various aberrations.

18563 GENERAL CONSIDERATION OF THE CATACAUSTIC OF SURFACES OF REVOLUTION. Z.Bartkowski.

Optik (Germany), Vol. 18, No. 1, 22-6 (1961). In German.

General equations for the catacaustic of a surface of revolution are given in parametric form. The inverse problem is also solved, so that the catacaustic associated with a given bundle of rays can be used as a basis for calculation of the form of the surface of revolution.

18564 REFLECTION OF RADIATION BY AN INFINITE FLAT SURFACE, ILLUMINATED FROM A POINT SOURCE. II. PARTICULAR CASES, IMPORTANT FOR PRACTICAL APPLICATIONS. B.A.Grigor'ev, A.G.Ershov and V.A.Uvarov.

Optika i Spektrosk. (USSR), Vol. 10, No. 2, 198-208 (Feb., 1961). In Russian.

In Pt I see Abstr. 12869 of 1961. Basic particular cases, which are important for practical applications, are examined on the basis of an investigation of the characteristics of the radiation field previously conducted by the authors. The basic equations are derived and are used for the analysis and the numerical calculation of characteristics; values of moduli of reflected illumination are also tabulated for ideally diffused and for specular reflection. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 2, 100-4 (Feb., 1961)].

18565 MEASUREMENTS ON PARABOLIC MIRRORS. R.Wehn.

Z. InstrumKde (Germany), Vol. 69, No. 8, 228-30 (Aug., 1961). In German.

Various methods of testing are reviewed. It is pointed out that in practice the artificial star can be placed at a finite distance from the mirror. The applicability of the Rayleigh tolerance to these systems is briefly discussed. N.Murcott

18566 SPHERICAL LENSES FOR INFRARED AND MICRO-WAVES. G.Toraldo di Francia.

J. appl. Phys. (USA), Vol. 32, No. 10, 2051 (Oct., 1961).

A class of Luneberg lens is described having a high outer refractive index and a constant inner refractive index. An example using $n_1 = 3.4$ and $n_2 = 2.665$ is quoted and shown to have double correction of spherical aberration with little zonal error. Such a system could be used as an infrared microscope objective with NA = 1. Another use is in microwave collimators. R.W.Fish

18567 THE INFLUENCE ON CONTRAST TRANSMISSION FUNCTIONS OF APODIZATION.

R.Röhler and F.Wittmann.

Optik (Germany), Vol. 17, No. 9-10, 530-5 (Sept.-Oct., 1960). In German.

A method for the production of sine-wave gratings is described. Contrast transmission functions obtained with the aid of these gratings for several lenses with and without apodization filters are discussed.

18568 NOTES ON THE DE-CENTRING OF SPHERICALLY SURFACED, SINGLE LENSES. C.Hofmann.

Jenaer Jahrbuch (Germany), 1960 II, 341-63. In German.

After reviewing previous work on decentring, a new definition is derived and applied to single lenses, including menisci. Formulae are given for the position of the image formed by such systems. R.W.Fish

18569 THE DEPENDENCE ON POSITION OF THE SEIDEL ABERRATIONS. H.Slevogt.

Optik (Germany), Vol. 17, No. 9-10, 510-18 (Sept.-Oct., 1960).

As already shown (Abstr. 6098 of 1951) the dependence of the Seidel aberrations on the position of the object can be deduced if the aberrations of the principal ray are used. The formulae which emerge are particularly simple to interpret if the reduced aberrations are expressed as a function of the reciprocal ray-distance D. By calculation of an additional surface element coefficient Θ_ν, the usual Seidel calculation (following Berek) is extended to contain all the data necessary for a description of the dependence on object position.

18570 RESULTS OF THE MEASUREMENT OF CONTRAST TRANSMISSION FACTORS COMPARED WITH THE GEOMETRICAL-OPTICAL CORRECTION.

J.Schilling and H.Zöllner.

Optik (Germany), Vol. 17, No. 9-10, 453-8 (Sept.-Oct., 1960). In German.

Measured values of contrast transmission factors are compa with values calculated by a method using the geometrical-optical approximation. The results do not indicate complete agreement, serve to show that the calculation of several contrast transmissi factors is nevertheless useful for the assessment of an optical construction.

18571 A NEW DEFINITION OF THE CENTRING ERROR OF SINGLE SPHERICAL LENSES. C.Hofmann.

Optik (Germany), Vol. 17, No. 9-10, 465-84 (Sept.-Oct., 1960). In German.

It is shown that the generally accepted definition by a single quantity, for example the shift of the axis or the wedge angle, is adequate for an exact description. A new definition of centring e by means of three independent quantities is suggested. It is also shown that the wedge angle emerges from the new general definiti as a special case for lenses whose edge thickness is small in comparison with their diameter. Finally, a procedure for the det mination of the position of the geometrical axis relative to the opt axis of a single spherical lens is described, based on the three ne parameters defining centring error.

18572 APPLICATION OF A DIFFRACTION EFFECT OF MULTIPLE-BEAM INTERFEROMETRY TO DETERMINING THE SPHERICAL ABERRATION OF AN OBJECT

G.Simonsohn.

Optik (Germany), Vol. 18, No. 6, 255-63 (June, 1961). In German

The interference in an air slit between plane plates of silver glass was observed using transmitted light. The first glass mirr encountered by the light was given a silver layer of low transmis containing a narrow groove. The width of the groove was 2-3 μm and a typical separation d of the mirrors 8 μm. Diffracted radia emerged in the immediate neighbourhood of the groove. The angl between the radiation and the normal to the mirrors is given by $n = 2d\nu.\cos\theta$ (ν = wave number). If an image of the space between mirrors was formed, an interferogram appeared consisting of "θ-fringes" as well as the normal interference fringes and the transverse spherical aberration of the imaging lens could be rea from the form of a θ-fringe. The technique was employed of observing fringes of equal chromatic order. It is also possible a leads to a particularly simple apparatus, to make use of fringes equal width.

18573 SEIDEL THEORY OF THE TWO-COMPONENT TELEOBJECTIVE. H.Slevogt.

Optik (Germany), Vol. 18, No. 7, 313-19 (July, 1961). In German.

Expressions for the Seidel aberrations are given and discuss for the case of a two-component telephoto lens in which the two halves ("telepositive" and "telenegative") are composed of thin lenses. Argentieri's formulae can be used if this assumption is made. If both components are aplanatic, astigmatism and field curvature can also be removed by suitable choice of powers, only pincushion distortion remaining. If the antisymmetrical correcti ($A_{II} = -A_I$, $B_{II} = B_I$ together with $\varphi_{II} = -\varphi_I$ and $\delta_{II} = -\delta_I$) is appl it is possible to correct all the Seidel aberrations. Explicit form are given for the aberrations A, B of the two components. As is shown by a numerical example, the radii of curvature of the lens can be calculated directly; there is satisfactory agreement with values obtained by a design procedure using trigonometric ray tracing.

18574 INFORMATION THEORY, THE BOHR—ROSENFELD UNCERTAINTY PRINCIPLES AND THE PROBLEM OPTIMIZED OPTICAL IMAGERY. R.S.Ingarden.

Acta phys. Hungar., Vol. 13, No. 1, 35-56 (1961). In German.

An expression for the number M of distinguishable light leve in an optical image is derived by making use of the uncertainty principle. Then if N is the number of degrees of freedom in the image, as given by a generalization of Gabor's expansion theore $M.N = C^2$, where C is a large dimensionless constant independent the wavelength. Thus M and N are not independent and it is show that there is an optimum value of N, and thus an optimum wavele for maximum information content in an optical image. In a cerical example for a photographic emulsion this optimum wave-gth lies in the range $0.2\ \mu$ to $2\ \mu$. W.T.Welford

18575 THE DISTRIBUTION OF LIGHT IN THE IMAGE SPACE OF AN OPTICAL SYSTEM IN THE PRESENCE OF IRD-ORDER ABERRATIONS OF UNRESTRICTED SIZE, CLUDING THE CASE OF THE ANAMORPHIC IMAGE.

R.Keller.
tik (Germany), Vol. 17, No. 11, 611-32 (Nov.); No. 12, 641-62
ec., 1960). In German.

Diffraction theory is applied to an anamorphic, afocal system any desired third-order aberration of unrestricted magnitude. e procedure developed can also be applied to rotationally nmetrical systems. The Gaussian image point is chosen as gin of a right-angled coordinate system, and is the centre of rvature of a sphere of reference U, which passes through the ntre of the exit pupil. The separation between the Gaussian image nt and the optical axis is denoted by either σ or σ', depending on ether the sagittal or meridian plane is under consideration, since anamorphic system possesses different magnifications in two itually perpendicular sections. The position of a point in the exit oil is indicated by the polar coordinates r and φ, while a point in image plane is represented by ρ and ψ. For a system free from erration, U becomes a wave surface for a pencil of rays iverging on the Gaussian image. The departure of the actual vefront from the reference sphere U is given by an aberration iction $V(\sigma, \sigma', r, \varphi)$. For the afocal, anamorphic system discussed re, a single aberration can be expressed by the function $r^n \sin^n \varphi$. The diffraction theory treatment is carried out. Each ividual aberration and the interaction of all the aberrations are vestigated. The latter represents the case occurring in practice. plication of the remainder theorem from the theory of functions duces the two-dimensional problem to a one-dimensional one. In cases integrals appear which depend on only one variable, mely r. The integration is carried out by means of Simpson's le; the numerical evaluation was performed with a programme-ntrolled electronic computer. The calculated patterns of light stribution are discussed. Several small-scale measurements nfirm the theoretical conclusions in outline.

18576 THIRD-ORDER ABBERATIONS IN ANAMORPHIC SYSTEMS.

K.Bruder.
tik (Germany), Vol. 17, No. 12, 663-70 (Dec., 1960). In German.

Continuing earlier work by Köhler (Abstr. 4973 of 1956), pressions are given for third-order aberrations in doubly-mmetric systems which provide anamorphic images, both for ose systems composed of toric surfaces and for those using lindrical surfaces with parallel axes.

18577 INVESTIGATION OF THE OPTICAL PROPERTIES OF TRANSPARENT MATERIALS AT ULTRA-HIGH ESSURES.

.B.Zel'dovich, S.B.Kormer, M.V.Sinitsyn and K.B.Yushko.
kl. Akad. Nauk SSSR, Vol. 138, No. 6, 1333-6 (June 21, 1961).
Russian.

For abstract, see Abstr. 16065 of 1961. [English translation Soviet Physics—Doklady (USA), Vol. 6, No. 6, 494-6 (Dec., 61)].

18578 GRAPHICAL DETERMINATION OF THE OPTICAL CONSTANTS FROM TWO TRANSMISSION VALUES.

Vaśko and M.Miler.
ech. J. Phys., Vol. 11, No. 4, 283-5 (1961). In German.

The optical constants of a material in a region of weak sorption are usually determined from measurements of trans-ission and reflection. The measurement of reflection may give se to large errors, and an alternative method is proposed whereby e constants are determined from transmission measurements two different thicknesses. A nomogram is given to help the quick duction of the constants. R.W.Fish

18579 TRANSMISSION AND DISPERSION OF CERTAIN GLASSES IN THE INFRARED.

Vagner-Dewulf, J.Vincent-Geisse and Nguyen Tan Tai.
ev. Opt. (France), Vol. 39, No. 12, 578-86 (Dec., 1960).
French.

Transmittances and refractive indices of nine optical glasses, oduced by the Parra-Mantois Company, were measured between e visible region and the transmission limit in the infrared. A spersion formula, providing good agreement with the numerical data is proposed for each glass. The position of the infrared absorption bands were determined through reflection measurements.

18580 PROCEDURE FOR DETERMINING THE DEGREE OF LIGHT TRANSMISSION OF AN AFOCAL SYSTEM.

G.Hansen.
Optik (Germany), Vol. 17, No, 9-10. 491-500 (Sept.-Oct., 1960).
In German.

The influence of stray light on measurements can be avoided by means of very small light sources. Errors arising from the photometric apparatus are frequently more important. The dependence of photoelectric current on incidence angle and direction necessitates the use of an integrating sphere, which yields a low output. Systems with the same angular magnification are therefore compared. Particular attention is paid to departure from linearity in the relationship between light flux and photoelectric current. The effects of time fluctuations of source and receiver are eliminated by making the comparison measurements in rapid succession.

18581 ELEMENTARY DETERMINATION OF THE UNIT OF INFORMATION IN OPTICS.

S.Tesone and M.Silbert.
Atti Fond. Ronchi (Italy), Vol. 16, No. 4, 289-91 (July-Aug., 1961).
In Italian.

An information unit is proposed for optical instruments, on the basis of some ideas on the energy theory of the Ronchi resolving power. The unit is given by a half wavelength combined with the Michelson visibility coefficient. This allows an explanation of the behaviour of a uniformly illuminated field. The two concepts of "background" and "form" are introduced. The new quantity of "resolving vision" is defined.

18582 PREPARATION OF STANDARD LIGHT [SOURCES] WHOSE INTENSITIES DECREASE IN GEOMETRIC SUCCESSION.

W.Heinz and G.Simonsohn.
Optik (Germany), Vol. 18, No. 5, 244-9 (May, 1961). In German.

A pencil of rays emerging from a uniformly illuminated slit traversed successively a collimator lens, a wedge of small angle (e.g. 10 minutes of arc) silvered so as to transmit part of the light, and a projection lens. After multiple reflection inside the wedge, each incident parallel pencil was fanned out into a series of parallel pencils of light whose intensity fell off according to a geometrical progression. A corresponding series of images of the slit appeared in the focal plane of the projection lens. The ideal case of a plane parallel plate is of only theoretical interest and departures from it are found for all finite wedge angles. The sources of these errors are discussed. However, the results of measurements given here show that an apparatus can be constructed which, in practice, approximates sufficiently well to the ideal case.

18583 A NEW TELESCOPE EYEPIECE WITH EXTREMELY LARGE FIELD OF VIEW.

H.Köhler.
Optik (Germany), Vol. 17, No. 9-10, 500-9 (Sept.-Oct., 1960).
In German.

The development of telescope eyepieces presenting to the eye a field angle ($2w'$) of more than 90° was discontinued towards the end of the war but was later taken up again. The first result of this development was an eyepiece with a three-element Smyth lens, which gave an adequate field correction for a subjective field of view $2w' = 110^{\circ}$. Details of this eyepiece together with some observational results which seem typical for large fields of view are given.

18584 NOTES ON A NEW METHOD FOR SETTING UP TELESCOPES ON AN EQUATORIAL MOUNTING.

F.Drago, G.Noci and M.Rigutti.
Atti Fond. Ronchi (Italy), Vol. 16, No. 4, 292-6 (July-Aug., 1961).
In Italian.

The method is described. Some experimental results concerned with the setting up of the Amici equatorial, at Arcetri Observatory, are given.

18585 CONFERENCE ON OPTICAL INSTRUMENTS AND TECHNIQUES — LONDON 11-14 JULY 1961.

W.J.Bates.
J. sci. Instrum. (GB), Vol. 38, No. 1, 417 (Nov., 1961).

A report of a conference arranged by the British National Committee for Optics under the auspices of the International Commission for Optics. About 200 people were present, drawn from 22 countries. The topics covered were extremely diverse, the emphasis being on modern developments, for example (a) the optical systems associated with rocket and satellite programmes, (b) optical masers.

18586 COLLOQUIUM ON OPTICAL MATERIALS — PARIS 1961. K.M.Greenland.
J. sci. Instrum. (GB), Vol. 38, No. 11, 418-19 (Nov., 1961).

A report on a colloquium held on July 5-8, 1961, and organized by the Comité Francais d'Optique for the International Commission for Optics. Among the topics covered were: synthetic crystals and polarizing materials, glass materials, thin films and techniques for the examination of glass.

18587 RECORDING REFRACTOMETER FOR MEASURING REFRACTIVE INDICES OF OPTICAL GLASSES OVER A WIDE RANGE OF WAVELENGTHS.
M.J.C.Flude, K.J.Habell and A.Jackson.
J. sci. Instrum. (GB), Vol. 38, No. 11, 445-8 (Nov., 1961).

A description is given of a spectrometer on which refractive indices of prismatic specimens have been measured from the near ultraviolet to the near infrared. The relationships between accuracy of measurement and tolerance on angle measurement and wavelength are considered. Values of refractive index for six optical glasses are quoted for the wavelength range 366 mμ to 2300 mμ and with an estimated accuracy of ±0.00003 or better.

18588 METHODS OF MICROSCOPY WITH OBJECTS AT A DISTANCE. P.Metzner.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 1, No. 7-10, 423-8 (1959). In German.

Brief description of two methods, the flying-spot microscope and the conventional microscope with a periscopic relay system, for viewing radioactive objects at a safe distance.

W.T.Welford

18589 THE DOUBLE MICROSCOPE FOR VISIBLE LIGHT. E.Lau.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 1, No. 7-10, 478-83 (1959). In German.

Two objectives are used in series with a rotating ground glass screen at the intermediate real image. Photographs are reproduced to support the claim that this arrangement justifies a larger overall magnification than is usually used with the given objective numerical aperture. W.T.Welford

18590 MICROSCOPE OBJECTIVE MADE FROM TWO SPHERICAL MIRRORS. B.Jurek.
Optik (Germany), Vol. 18, No. 9, 413-21 (Sept., 1961). In German.

Design data for reflecting microscope objectives are derived by use of suitable approximation methods.

18591 OPTICAL MICROSCOPY WITH MECHANICAL PRE-MAGNIFICATION. E.Menzel and K.Hohlfeld.
Z. Phys. (Germany), Vol. 164, No. 5, 522-8 (1961). In German.

By mechanically stretching a rubber replica prior to examination, the limits of resolution of the optical microscope (according to Abbe) may be exceeded. Replica and stretching can be described by a relief transfer function similar to that used in optical transfer theory. This function was attained from the transfer of a step of mica. It is possible to describe the process as a linear transfer channel within the limits given.

18592 DECOMPOSITION OF SPECTRAL INTENSITIES INTO GAUSSIAN CURVES. L.G.Preuss and J.P.Escarfail.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 212-20 (Nov., 1960). In French.

The increasing precision of measuring methods such as nuclear spectrography calls for a fast and sensitive method of decomposition into Gaussian curves, particularly if a suspected smaller maximum is smoothed out by a neighbouring band. The resulting asymmetrical intensity curve is then often considered as the sum of two curves described by the formula $y_i = D_i \exp[-\{(\nu - \nu_i)/h_i\}^2]$ and having a common half-width h. A simple graphical method is proposed which allows one to check whether such a decomposition is significant to a given degree of accuracy. It also gives accurate values for the parameters D_1, D_2, ν_1, ν_2 and h with comparative ease. It follows, even in the general case, that an automatic recording of the logarithmic derivative on which this method is based will allow a more critical insight of any such intensity curve known to better th 1%, by making full use of the available precision. This in turn strongly suggests the use of a computer coupled to the spectrograph for that purpose.

18593 THE USE OF PRESSED DISKS OF KCl IN ULTRA-VIOLET SPECTROPHOTOMETRY.
V.A.Shlyapochnikov and V.I.Slovetskii.
Optika i Spektrosk. (USSR), Vol. 10, No. 2, 265 (Feb., 1961). In Russian.

Organic materials were compacted with KCl to form disks w parallel polished sides. The u.v. absorption spectra of such disk were found to agree qualitatively with those of solutions of the organic materials. Examples of n-nitrotoluol and n-nitroaniline are given. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 2, 132 (Feb., 1961)]. W.T.Welf

18594 DEVICE FOR DETERMINING THE POSITION OF TH ABSORPTION EDGE.
R.Schläfer, E.Hillmann and N.Neuroth.
Z. InstrumKde (Germany), Vol. 69, No. 7, 208-11 (July, 1961). In German.

A method is described for rapid measurement of the spectral position of the absorption cut-off of a sample, e.g. a filter glass, without drawing the transmission curve.

SPECTRAL ANALYSIS. TYPES OF INTEGRALS AND CONVOLUTIONS. See Abstr. 18553

PHOTOELECTRIC STUDY OF SPECTRAL LINEWIDTHS. See Abstr. 18605

18595 MEASUREMENT OF THE OPTICAL DENSITY OF TH BLACKENING OF SPECTRAL LINES USING INTERFERENCE MICROSCOPY METHODS.
V.P.Koronkevich and É.B.Kolesova.
Optika i Spektrosk. (USSR), Vol. 10, No. 2, 268-70 (Feb., 1961). In Russian.

A multiple-beam interference microscope is used to measure the blackening through variations in microprofile of the photograp material. Examples are compared with microphotometer tracing The microphotometer has greater accuracy, and is more sensitiv for smaller blackenings, but the interference method can be satisfactorily applied to higher blackening values than microphotomete It is also rapid and experimentally simple. [English translation i Optics and Spectrosc. (USA), Vol. 10, No. 2, 135-6 (Feb., 1961)].

J.Sheri

18596 SPECTROMETER OF VERY HIGH LUMINOSITY FOR THE FAR INFRARED. APPLICATION TO THE STUD OF ABSORPTION OF CRYSTALLINE ALKALI HALIDES BETWE 250 AND 650 μ (40 TO 15 cm^{-1}). A.Hadni and C.Janot.
Rev. Opt. (France), Vol. 39, No. 10, 451-7 (Oct., 1960). In Frenc

Description of a medium size spectrometer for the far infra Gives measurements for the rotation spectrum of water vapour (250-650 μ). Also the absorption spectra of NaCl, KBr, KI, exhibiting the difference band between the least optical frequency and the largest acoustical one. This band is predicted by theory but had not been previously observed.

18597 A RECORDING AND AMPLIFYING RECEIVER FOR SHORT-TIME SPECTROGRAPHY.
R.Schneider, F.Maisenhälder and M.Kling.
Z. angew. Phys. (Germany), Vol. 13, No. 4, 211-15 (April, 1961). In German.

The apparatus is designed for examination of spectra having durations of 10^{-7} sec or less. The photographic plate in a spectr graph is replaced by an image convertor with a long-persistence screen. This is scanned by a rotating mirror and the light is reflected to a photomultiplier, followed by an amplifier and an oscilloscope. The image convertor acts as an optical gate, being switched by a pulse applied to a grid. The spectra of very-short-duration discharges can thus be scanned in a time which is relatively long because of the persistence of the screen.

W.G.Str

18598 A MICROSPECTROGRAPH FOR ABSORPTION MEASUREMENTS IN ULTRAVIOLET LIGHT.

uch.
wiss. Mikr. (Germany), Vol. 64, No. 8, 453-68 (Nov., 1960).
erman.

The instrument is a combination of a reflecting microscope and pectrograph. The light absorption at different wavelengths is orded simultaneously on a photographic plate. The light source hydrogen lamp. Focusing in the slit of the spectrograph is ected in visible light by means of a special phase-contrast system. ow pressure mercury arc is used for monochromatic micro- tographs at a wavelength of 253.7 μm. The density is calibrated a rotating sector. Densitometer records of the absorption may obtained from the spectrograms in two ways: by recording the ctral absorption at a point in the object and by recording the orption through the object at a given wavelength. The accuracy advantages of the method are discussed.

A SELF-RECORDING GRATING SPECTROPHOTOMETER.

Abstr. 18417

18599 INTENSITY RATIO IN THE MERCURY SPECTRUM OF LOW PRESSURE DISCHARGE LAMPS.

oser and R.Ritschl.
natsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 11, 9 (1960). In German.

18600 INVESTIGATION OF ATOMIZERS FOR EMISSION AND ABSORPTION FLAME PHOTOMETRY. R.Herrmann.

ik (Germany), Vol. 18, No. 9, 422-30 (Sept., 1961). In German.

The fundamental atomization characteristics and their endence on the construction of the atomizer, in particular on the face area of the annular slit, are discussed. The relation ween these characteristics and the experimental requirements lame photometry for emission and (atom) absorption are sidered.

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

18601 THE REVERSIBILITY AND RECIPROCITY PRINCIPLES. A.Vašíček.

ik (Germany), Vol. 18, No. 6, 267-77 (June, 1961). In German.

The use of the principles in optics is discussed in detail and characteristic differences between them emphasized. Their lication to the theory of thin films is considered, and formulae uced for the reflection and transmission of light in the theory of transparent and absorbing films.

18602 TRANSMISSION OF MONOCHROMATIC INFRA-RED RADIATION BY A PRISMATIC FILM OF VERY ALL ANGLE. R.Duverney.

Phys. Radium (France), Vol. 21, No. 12, 895-6 (Dec., 1960). French.

A selenium film, as made by vacuum evaporation and used in infrared polarizer, is approximately a very thin prism. A mula for the infrared transmission of such a film is derived. e calculated values of transmission are in good agreement with eriment. J.N.Hodgson

18603 INFLUENCE OF MAXIMUM OPTICAL PATH DIFFERENCE AND OF NOISE IN INTERFEROMETRIC ECTROSCOPY. M.Schubert.

tik (Germany), Vol. 18, No. 3, 147-56 (1961). In German.

The accuracy which can be attained in interferometric ectroscopy (time variation of the optical path difference with nstant velocity) is investigated. The spectrum emerging from the trument is an approximation to the true spectrum, and the endence of the deviations from the true spectrum on the para- ters of measurement are given, without special assumptions cerning the spectrum to be measured. The results are npared with those obtained under equivalent conditions by nning methods (grating and prism spectrometers).

18604 PHOTOELECTRIC DETECTION OF INTERFERENCE BETWEEN TWO LIGHT BEAMS HAVING A LARGE PATH DIFFERENCE. M.P.Givens.

J. Opt. Soc. Amer., Vol. 51, No. 9, 1030-2 (Sept., 1961).

A theoretical discussed. An experiment is in which a pulsed spark source is viewed by a photomultiplier both directly and as a reflection from a distant mirror. From an analysis of the frequency spectrum of the photomultiplier output it is possible to deduce the time difference. The problem is treated as a problem in propagation of waves. Questions of coherence are discussed. An experiment is proposed whereby the velocity of light can be measured in the laboratory using the calculations made. S.Tolansky

18605 PHOTOELECTRIC STUDY OF SPECTRAL LINEWIDTHS.

M.P.Givens.

J. Opt. Soc. Amer., Vol. 51, No. 9, 1032-3 (Sept., 1961).

Previous theory (see preceding abstract) shows that the frequency distribution of the output current of the photomultiplier is determined by the shape and width of a narrow incident spectral line. Expressions allowing linewidth determination are given for Gaussian and Lorentzian shapes. A study of sufficiently wide ranges of frequency distribution can differentiate between these shapes. The necessary practical procedures are indicated. J.Sheridan

18606 RADIAL SHEARING INTERFEROMETER.

P.Hariharan and D.Sen.

J. sci. Instrum. (GB), Vol. 38, No. 11, 428-32 (Nov., 1961).

A new type of wave front shearing interferometer is described in which two images of the wave front under test which are of different sizes are made to interfere. When the centres of the two images coincide, this results effectively in shear along the radial direction. It is shown that the interpretation of the resulting interferogram is comparatively easy. In addition, the instrument is extremely convenient to handle since all the adjustments can be made with a white light source.

18607 AN AUTOCOLLIMATION SYSTEM FOR PHOTOELECTRIC RECORDING OF HYPERFINE STRUCTURE.

A.G.Zhiglinskii, A.N.Zaidel' and G.G.Kund.

Optika i Spektrosk. (USSR), Vol. 10, No. 6, 792-6 (June, 1961). In Russian.

A design for an apparatus with double passage of light through a Fabry–Perot interferometer is proposed for producing and photoelectrically recording high contrast interference patterns. The parameters of the equipment are investigated. For example, recordings of the hyperfine structure of lead lines indicate that the contrast of the interference pattern obtained with the proposed design is greater than is the case with designs ordinarily employed, even when using interferometer mirrors having high reflection coefficients. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 6, 418-20 (June, 1961)].

18608 THE MICHELSON STELLAR INTERFEROMETER: A PHASE SENSITIVE VARIATION OF THE OPTICAL INSTRUMENT. R.C.Jennison.

Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 596-9 (Oct., 1961).

A short summary is given of a variation of the Michelson stellar interferometer. This is an adaption of part of the principle of the radiofrequency phase-sensitive inferferometer developed by the author in 1958 and it enables the phase component associated with the structure of the source to be determined. The technique may also be used to determine the correct relative amplitude of the visibility function of the star at two spacings even when phase and amplitude errors are present.

18609 THE SPHERICAL FABRY–PEROT INTERFEROMETER AS AN INSTRUMENT OF HIGH RESOLVING POWER FOR USE WITH EXTERNAL OR WITH INTERNAL ATOMIC BEAMS.

D.A.Jackson.

Proc. Roy. Soc. A (GB), Vol. 263, 289-308 (Sept. 19, 1961).

The spherical Fabry–Perot interferometer was designed by Connes (Abstr. 16873 of 1960) as an instrument capable of realizing higher resolving power than the normal Fabry–Perot interferometer, by virtue of its greater light power at high resolution, and the much lower requirement with regard to accuracy of adjustment. The instrument was used successfully in the resolution of structure in the resonance line of the arc spectrum of barium; components with a separation of $2{\cdot}0 \times 10^{-3}$ cm^{-1} were resolved; they were observed in the absorption produced by a Jackson—Kuhn atomic beam, of high collimation. The instrument was also used for observing line structure with an absorbing atomic beam traversing the interior of the interferometer; by this means the amount of material required for observing hyperfine structure using an atomic beam, even with very high collimation, can be reduced to a few milligrams, or approximately 100 times less than that required with an atomic beam external to the interferometer, so that enriched isotopes, available in small quantities, can be used; alternatively, adequate absorption can be obtained with much higher collimations of the beam, and correspondingly improved limits of resolution.

18610 A PHOTOELECTRIC INDICATOR FOR THE MEASUREMENT OF INTERFERENCE FRINGES.

W.Boguth and F.Habermalz.
Z. wiss. Mikr. (Germany), Vol. 64, No. 7, 395-7 (Oct., 1960). In German.

A simple setup is described permitting the exact photometric measurement of interference fringes with the aid of a measuring microscope, a projection device, a photo-diode, and an indicator valve.

18611 PHASE ANALYSER WITH A PROGRESSIVE ULTRASONIC WAVE.

W.Tausendfreund and R.Seiwert.
Optik (Germany), Vol. 18, No. 4, 163-77 (April, 1961). In German.

The construction of a phase analyser with a progressive ultrasonic wave is described. The sources of error of the various types of design (temperature and frequency variations; superposition in the image plane of the fringe systems formed by stray light and fluorescent light incident on the ultrasonic wave) are discussed and the necessary conditions for adjustment presented.

18612 COMPLEX WIDEBAND ULTRASONIC RADIATORS FOR DIFFRACTION-TYPE LIGHT MODULATORS.

I.I.Adrianova, M.V.Kokurina and Yu.V.Popov.
Akust. Zh. (USSR), Vol. 6, No. 4, 495-6 (1960). In Russian.
English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 4, 492-3 (April-June, 1961).

18613 A NOTE ON THE DIFFRACTION OF A SCALAR WAVE BY A SMALL CIRCULAR APERTURE.

R.A.Hurd.
Canad. J. Phys., Vol. 39, No. 7, 1065-70 (July, 1961).

The power series solution for the diffraction of a scalar plane wave incident normally on a small circular aperture in a hard screen is extended to include terms of order α^{12} in the aperture field, and to terms of order α^{10} in the transmission coefficient ($\alpha = 2\pi \times$ radius of aperture/wavelength). To do this, a set of recurrence relations is developed, and a relatively simple method of obtaining the transmission coefficient is devised.

18614 CALCULATION OF THE TRANSMISSION FACTOR IN THE DIFFRACTION AT A SLIT OF A P-POLARIZED PLANE [ELECTROMAGNETIC] WAVE, BY AN APPROXIMATION METHOD.

F.Loges.
Optick (Germany), Vol. 18, No. 2, 49-58 (1961). In German.

18615 THEORETICAL AND EXPERIMENTAL STUDY OF TWO ASPECTS OF DIFFRACTION BY GRATINGS: [I] CAUSES OF DEFECTS IN SPECTRUM LINE PROFILES AND [II] ELECTROMAGNETIC THEORY OF LIGHT DISTRIBUTION AMONG DIFFERENT ORDERS.

G.W.Stroke.
Rev. Opt. (France), Vol. 39, No. 7-8, 291-396 (July-Aug., 1960). In French.

Part I describes the measurement of phase errors in diffracted wavefronts by means of a Twyman—Green interferometer and the numerical evaluation of the Fourier transform to give the spectrum line profile for a perfectly narrow line (instrumental profile); several examples are given of grating interferograms, computed profile and photographed profile using an isotope lamp to obtain a narrow line. Part II gives a strict solution according to Maxwell's equations for the relative intensity distribution among orders for a perfectly reflecting sinusoidal grating and suggests possible methods for an arbitrary profile of grating ruling. Some particular predictions for rectangular rulings were verified with microwaves. W.T.Welford

18616 EXTENSION OF THE CORNU DIAGRAM TO THE CAS OF A PARTIALLY TRANSPARENT AND PHASE-SHIFTING HALF-PLANE.

F.Lenz.
Z. Phys. (Germany), Vol. 164, No. 4, 425-7 (1961). In German.

Cornu's diagram for the graphical evaluation of intensity distribution in the Fresnel diffraction phenomena behind an opaque half-plane is generalized to the case of diffraction by a half-plane with arbitrary values of transparency and phase-shift.

18617 NOTE CONCERNING THE MIE SCATTERING OF UNPOLARIZED INCIDENT RADIATION.

B.M.Herma
J. Meteorol. (USA), Vol. 18, No. 4, 558-60 (Aug., 1961).

The confusion that exists over a factor of 2 in the formula ma be resolved readily by averaging the formula for polarized radiation over all directions of polarization. A.R.Stok

18618 STUDIES OF LIGHT SCATTERING BY THIN GRANULAR SILVER FILMS.

D.Grigorovici, G.Ciobanu and E.Toma.
Rev. de Physique (Roumania), Vol. 5, No. 3-4, 367-81 (1960). In German.

Granulation was induced in evaporated silver films by heating in vacuo, giving flattened spheres with diameters in the range 0.02 μ to 0.2 μ. Scattering was measured as a function of angle an size for the Hg yellow lines, also the wavelength dependence for several angles. Approximate agreement with Mie theory was foun allowing for the flattening of the spheres and other disturbing effe 25 references. W.T.Welfo

18619 RANDOM, PLANE-POLARIZED COMPONENTS IN ORDINARY, UNPOLARIZED LIGHT.

P.Hariharan and R.G.Singh.
J. Opt. Soc. Amer., Vol. 51, No. 10, 1148-9 (Oct., 1961).

A description is given of a method for detecting the presence of linearly polarized vibrations of random and changing orientatio in unpolarized light. The method uses a quartz plate a few millimeters thick, in conjunction witha triangular path interferometer (Abstr. 7996 of 1959) and a pocket spectroscope. A diagram of the experimental arrangement is given and some typical interference patterns shown. H.G.Jerra

18620 MEASUREMENT OF THE DEGREE OF POLARIZATIC USING A SET OF COMPENSATING GLASS PLATES.

A.Kawski and A.Skwierz.
Optik (Germany), Vol. 18, No. 5, 234-43 (May, 1961). In German.

For Pt III see Abstr. 10881 of 1959. The formulae expressing the degree of polarization of an Arago compensator consisting of any number of glass plates are discussed. The range of applicatic of the Neumann formula in techniques of measurement is indicated and an analysis of the errors of the Neumann equation associated with the refractive index n and the angle of incidence a is given. The effect of the dispersion of the Arago compensator on measurements of the degree of polarization of fluorescent solutions, using sensitive dynamic photoelectric methods, was also investigated. accuracy of 10^{-4}-10^{-3} was obtainable depending on the measured value. Limitations on accuracy arising from the Arago compensat itself were observed.

18621 USE OF POLARIZERS WITH SMALL DEGREE OF POLARIZATION IN THE INFRARED.

G.Heilmann.
Optik (Germany), Vol. 18, No. 9, 440-4 (Sept., 1961). In German.

A procedure is described which enables measurements requiring, in principle, strictly plane polarized light to be perforn even when the available polarizer gives a degree of polarization substantially less than 1, and furthermore when its characteristic cannot be determined by joining it to a perfect polarizer. These conditions are encountered in the infrared above about 36μ. The expressions deduced are applied to a transmission polarizer charged with polyethylene.

18622 THE EMISSION OF POLARIZED LIGHT BY INCANDE CENT METAL SURFACES, AND ITS SPATIAL INTEN SITY DISTRIBUTION.

V.v.Keussler and P.Manogg.
Optik (Germany), Vol. 17, No. 11, 602-10 (Nov., 1960). In German

Using the Fresnel formulae for the electric vector of the light an analogous formulae for the magnetic vector, relations for the pola ization rate of light emitted by incandescent metals are derived a function of the emission angle. Expressions are also given for the tive intensities of the spatial light distribution, which deviate ı the Lambert cosine law. The results were compared with the :ise measurements made by Worthing and excellent agreement ıd.

:8623 NEW PHOTOELECTRIC METHOD OF MEASURING THE DEGREE OF POLARIZATION OF LIGHT.

auer and M.Rozwadowski.
ik (Germany), Vol. 18, No. 1, 37-41 (1961). In German.

A photoelectric apparatus is described which enables ısurements of the degree of polarization of the light from feebly inescent substances to be made with high accuracy. The ·ease in sensitivity is achieved by raising the frequency of the t modulation by use of a new type of modulator.

·8624 A STUDY OF THE MEASUREMENT OF THE PHASE DIFFERENCE IN DOUBLY REFRACTING PLATES ༄G THE SOLEIL—BABINET COMPENSATOR.

linnagel.
nstrumKde (Germany), Vol. 69, No. 3, 79-83 (March, 1961). erman.

Irregularities in measurements on phase plates are investi- ·d. It is established that these arise from phase changes ıugh internal reflections within the doubly refracting plates. se value is an oscillating function of wavelength. This is lied in detail. Data are reported for thin sheets of mica.

S.Tolansky

COLORIMETRY . PHOTOGRAPHY

18625 COLORIMETRIC DAYLIGHT ILLUMINANT WITH HIGH ULTRA-VIOLET CONTENT. B.Hisdal.

.ica Acta (Internat.), Vol. 8, No. 3, 199-212 (July, 1961).

For colorimetry of daylight fluorescent materials, a daylight ıminant of higher ultraviolet energy content than that of source s needed. In an earlier paper it was shown that an increase in raviolet energy can be obtained by supplementing source C with ›ther source containing a tungsten lamp and an ultraviolet trans- tting filter. Newer data indicate that the ultraviolet content of rage daylight may be considerably higher than that assumed in previous paper. The purpose of this investigation is to see at kind of approximation to this type of ultraviolet energy distri- ion is possible, using the same arrangement as before. It is ›wn that an approximation, satisfactory for all cases of daylight orescent colorimetry can probably not be obtained with only one ›plementary source, using conventional filters and reasonable ngsten) lamp intensities. A satisfactory solution for the type of raviolet distribution involved seems to require at least two ›plementary sources. Examples of spectral energy distributions :ainable with one and with two supplementary sources are shown.

18626 REPERCUSSION OF SPECTROPHOTOMETRIC ERRORS ON COLORIMETRIC CALCULATIONS.

3lottiau and G.Bertrand.
v. Opt. (France), Vol. 39, No. 5, 209-23 (May, 1960). In French.

Tri-stimulus colorimetry is often done by computation from served spectral curves obtained with a spectrophotometer. The ·omaticity coordinates are in error because of errors made in spectrophotometer measurements. A method of calculating the orimetry errors is given which is somewhat simpler than that to Nimeroff (Abstr. 5988 of 1953; 7801 of 1957). The complete culation is given for a particular case by way of example.

H.G.Jerrard

18627 REMARKS ON THE THREE-DIMENSIONAL GEOMETRY OF COLOUR REPRESENTATION. P.Kowaliski.

v. Opt. (France), Vol. 39, No. 10, 458-66 (Oct., 1960). In French.

Disadvantages of several published colour coordinate systems making clear general properties of colour space and for rrelating with colour atlases are pointed out. A system in which ertain trio of spectral colours is represented by tri-rectangular s is proposed for these purposes. W.T.Welford

INTERFERENCE COLOUR. See Abstr. 18550

18628 PHYSICAL BEHAVIOR OF PHOTOGRAPHIC GRAINS. G.Sprague.

J. appl. Phys. (USA), Vol. 32, No. 11, 2410-20 (Nov., 1961).

A quantitative treatment of the photographic process is presented, modelled on the Gurney—Mott theory. This is extended by taking account of the photolytic silver distribution during and after exposure. The theory is applied to some simple types of sensitizing. The most important physical parameter of a photographic grain seems to be the number of electron traps.

18629 ACCURACY OF REPRODUCTION OF EQUAL DENSITY LINES. I. REPRODUCTION OF EQUAL-IRRADIATION CURVES BY PHOTOGRAPHIC EQUAL DENSITY LINES. W.Heinz.

Optik (Germany), Vol. 18, No. 3, 130-46 (1961). In German.

The lines oscillate statistically about given curves of equal irradiation The variation in density ΔS is related to the variation in position Δr by $\Delta S = \text{grad}\, S \,.\, \Delta r$. ΔS is mainly dependent on the density:

$$\Delta S = c\sqrt{S} \text{ or } \Delta S = c\sqrt{S + 0.3\, S^2},$$

where c is relatively insensitive to variations in the parameters of the photographic and, "equidensity" processes, and lies between 0.02 and 0.06 for the photographic materials of steep gradation which were investigated. Expressed as a function of the density, the mean variations in density after reduction to equal gradiation, and frequently in consequence the mean variations in position, exhibit minima in the region corresponding to the optimum for reproduction of fine detail ($S \simeq 0.8$). The observed variations can be shown to result from inhomogeneities in the photographic material and development process. Consequently, the resolving power of photographic "equidensities" is not limited by the grain, but by "cloudiness", random errors of the plate and variations in thickness of the emulsion.

18630 ACCURACY OF REPRODUCTION OF EQUAL DENSITY LINES. II. REPRODUCTION OF COORDINATE RELATIONS. W.Heinz.

Optik (Germany), Vol. 18, No. 5, 221-33 (May, 1961). In German.

If the required coordinates depend on the density, errors arise in an evaluation of the coordinates of density functions which are increased when the evaluation is carried out by means of lines of equal density. Only in certain specific cases, such as for a density distribution symmetrical about the maximum or the absence of background density, are no errors expected. Formulae for the departure of the coordinates of the equidensities from those of an ideal form (Δ -values) are given, and confirmed by measurements on photographs of interference fringes of the same chromatic order, a suitable approximation enabling the fringe maxima to be determined. Finally, the influence of the observed error on measurements of layer thickness is investigated. It is found that fairly large errors are especially likely if the layer and its support have different reflection coefficients.

18631 HYPERSENSITIZATION GAINS IN THE NEAR INFRARED. N.Sanduleak.

Astron. J. (USA), Vol. 66, No. 9, 526-8 (Nov., 1961).

The hypersensitization of the Kodak I-N emulsion with baths of plain water, triethanolamine, and ammonia was studied as part of a project aimed at increasing the effectiveness of objective prism detection of faint, cool stars. These agents were found to produce exposure gains of 2.1, 3.3, and 4.0, respectively, in the attainment of photographic density 0.6. The results apply to the spectral range of 6800 to 8800 A. They are valid for typical astronomical exposure times of 20 min to one hr.

18632 PHENOMENA OBSERVED ON PHOTOGRAPHIC EMULSION AND GLASS ON CONTACT WITH QUARTZ. B.V.Vitovskii and L.I.Tatarinova.

Kristallografíya (USSR), Vol. 4, No. 6, 931-3 (Nov.-Dec., 1959). In Russian.

The effect of placing a quartz plate in contact with an exposed photographic film for about a year, is to resensitize the film over the area of contact, and to cause the latent image to fade. The deposit formed on glass and celluloid when left for a long time in contact with a quartz plate,was found by electron difraction to contain a cubic crystalline phase (a = 5.68A) which was not identified. [English translation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 6, 888-90 (June, 1960)]. I.D.Brown

18633 THE BEHAVIOUR OF PHOTOGRAPHIC MATERIALS AND THE REPRODUCTION OF SMALL ISOLATED DETAILS. F.Hodam.
Optik (Germany), Vol. 17, No. 9-10, 521-9 (Sept.-Oct., 1960).
In German.

The character of a photographic image is given essentially by the correct reproduction, both geometrically and photometrically, of small, isolated details. For this special case, a procedure is described enabling the performance of photographic materials to be investigated experimentally and represented by curves.

18634 DEFINITION OF DENSITOMETER SPOT-PROFILE, CALLIER EFFECT, AND PHOTOGRAPHIC GRANULARITY. P.Vernier.
Rev. Opt. (France), Vol. 39, No. 11, 505-15 (Nov., 1960). In French.

A theoretical study of the intensity, and degree of coherence of the luminous flux received, scattered, and transmitted by an area of a uniformly exposed, and developed sample of photographic emulsion whose density is measured by a microphotometer. Account is taken of the statistical variation of density over the scanned area of the sample; and it is shown that, under rigorously restricted conditions of measurement, the relative S.D. of the optical density may be used as an index of photographic granularity, free from any instrumental effects. D.R.Barber

A NEW TECHNIQUE IN THE USE OF THE ELECTRONIC CAMERA. See Abstr. 17990

18635 AN AUTORADIOGRAPHIC EFFECT.
S.McLean; A.H.Meleka and W.Barr.
Nature (GB), Vol. 191, 690-2, 692 (Aug. 12, 1961).

The effects of certain metal powders on X-ray films when kept in contact was investigated as a function of temperature and gaseous atmosphere in which they were placed. It was observed that the nature of the atmosphere greatly affects the kind of radiation obtained from the same material. A marked effect of the temperature on the intensity of radiation was also noticed. Similarly an effect of radiation transfer from these exposed films to other films kept in contact with them for 24 hr or longer was also observed. Moreover information on the period of activity and range of radiations and life of the radiating bodies was also obtained. J.B.Garg

18636 THE DISTRIBUTION OF SPATIAL FREQUENCIES IN PHOTOGRAPHIC IMAGES. R.Röhler and F.Buchmann.
Optik (Germany), Vol. 17, No. 9-10, 459-75 (Sept.-Oct., 1960).
In German.

An apparatus for the Fourier analysis of photographic images, enabling the picture to be scanned in lines, is described. The mean frequency distribution of a typical picture is given, and mean values of the frequency distributions of various types of picture are discussed.

HEAT . RADIATION

18637 TEMPERATURE DISTRIBUTION IN A PIECE-WISE CONTINUOUS, SEMI-INFINITE PLATE.
E.I.Kim and B.B.Baimukhanov.
Dokl. Akad. Nauk SSSR, Vol. 140, No. 2, 333-6 (Sept. 11, 1961).
In Russian.

Considers the equation $u_t = a^2(u_{xx} + u_{yy})$, where u is the temperature and the suffixes denote differention. The plate is situated in the positive x-plane while a^2 has two different, constant values for positive and negative y respectively. The boundary conditions are specified in terms of general functions and solutions are found explicitly in terms of quadratures of these. [English translation in: Soviet Physics—Doklady (USA)]. J.K.Skwirzynski

18638 STEADY TEMPERATURE IN A COMPOSITE ELLIPTIC CYLINDER. V.Vodička.
J. Phys. Soc. Japan, Vol. 16, No. 8, 1630-6 (Aug., 1961).

Classical methods are used to determine the steady temperature distribution in a finite elliptic cylinder consisting of any number of plane-parallel layers. As illustration of the general procedure, the case of a homogeneous isotropic elliptic cylinder is treated in some detail.

18639 EXPERIMENTAL STUDY OF THERMAL CONTACT RESISTANCES; INFLUENCE OF PRESSURE.
H.Cordier.
Ann. Phys. (France), Vol. 6, No. 1-2, 5-19 (Jan.-Feb., 1961).
In French.

The preliminary results obtained in the investigation of Abstr. 10794 of 1960 are described together with details of the apparatus. S.Weintr

18640 ON MEASUREMENT OF THERMAL CONDUCTIVITY AT HIGH TEMPERATURES. M.J.Laubitz.
Canad. J. Phys., Vol. 39, No. 7, 1029-39 (July, 1961).

A method is given for exact mathematical analysis of linear heat flow systems used in measuring thermal conductivity at hig temperatures. It is shown that a popular version of such a syste is very sensitive to the alignment of its components, which seriously limits the temperature range of its satisfactory use.

18641 MEASUREMENT OF THERMAL CONDUCTIVITY OF SOLIDS AT LOW TEMPERATURES WITH THE AID C TEMPERATURE WAVES. F.X.Eder.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 86-91 (1960). In German.

A brief, and largely theoretical, discussion is given of this method. P.T.Landsb

18642 AN ACCURATE RAPID SEMI-DYNAMICAL METHOD FOR THE DETERMINATION OF THE THERMAL CONDUCTIVITIES OF POOR CONDUCTORS.
M.M.Qurashi and S.H.Rizvi.
Pakistan J. sci. industr. Res., Vol. 2, No. 4, 236-40 (Oct., 1959).

Gives a theoretical derivation of an expression for the rate o increase of temperature of the "brass disc" in Lees' disc method It is shown that if $\frac{d\theta}{dt}$ is plotted against the temperature of the bra disc a curve with a linear portion results, enabling the equilibriu temperature to be extrapolated. A considerable saving of time results. Experimental verification is given, using for this two samples of cement, one 5·6 mm and the other 24 mm thick. E.G.Know

18643 NOTE ON A FULLY DYNAMICAL VARIANT OF LEE DISC METHOD FOR THE RAPID DETERMINATION THE THERMAL CONDUCTIVITY OF POOR CONDUCTORS.
M.M.Qurashi, A.K.M.Ahsanullah and S.H.Rizvi.
Pakistan J. sci. industr. Res., Vol. 3, No. 2, 96-100 (April, 1960)

As an extension of a previous semi-dynamical method (see preceding abstract) utilizing the linearity of the plot of $\partial\theta/\partial t$ against θ, the temperature of the standard brass disk, a fully dynamical variant has been developed by extrapolating this linear plot backwards to the initial condition at $t = 0$. The experimental results indicate the necessity for a significant correction for los of heat from the periphery of the sample disk, an expression for which is derived. The experimental values obtained from the ful dynamical measurements are shown to be in satisfactory agreement (within ± 4%) with that obtained by the equilibrium method. The resulting formula contains a small term involving the specifi heat of the sample disk, which can be determined from two measurements, with a thin disk and a thick one.

18644 HEAT TRANSFER TO MERCURY IN A CIRCULAR TUBE AND ANNULAR CHANNELS WITH SINUSOIDA HEAT LOAD DISTRIBUTION. V.I.Petrovichev.
Internat. J. Heat Mass Transfer (GB), Vol. 1, No. 2-3, 115-20 (Aug., 1960).

To calculate the maximum wall temperature for a turbulent mercury flow in circular tubes with $l/d = 44{\cdot}6$ and 67 for a sinusoidal heat load distribution along the axis the following formula was derived

$$\theta_{\max} = \frac{(t_s)_{\max} - t_a}{t_b - t_a} = 0{\cdot}22\ Pe^{0.27}$$

at Pe = 400-3900, which can be used for the estimation of heat transfer in tubes with sinusoidal heat distribution sources. The experimental data were obtained on heat transfer to mercury whe $q = q_o \times \sin \pi x/l$ in annular channels with $d_m = 5{\cdot}4$ mm and 3·5 mm which can be used for comparative estimation. The experimental data qualitatively agree with the solution of the present problem on an electric integrator.

8645 A MECHANISM OF TURBULENT HEAT TRANSFER IN LIQUID METALS. N.Z.Azer and B.T.Chao.

rnat. J. Heat Mass Transfer (GB), Vol. 1, No. 2-3, 121-38 ., 1960).

A simplified mechanism of turbulent heat transfer, based on a ification of Prandtl's mixing-length hypothesis, is proposed. assumed that there is a continuous change of momentum and gy during the flight of the eddy. Two expressions giving the of eddy diffusivities for heat and momentum are obtained for developed pipe flow. One is for fluids of Prandtl number ging from 0·6 to 15 and the other for liquid metals. Both ectly predict the influence of Reynolds number, Prandtl ber and radial location across the pipe on the diffusivity ratio n compared to trends revealed by limited published data. iputations of Nusselt number and temperature profile in liquid als were carried out under conditions of constant wall flux g the deduced expression for diffusivity ratio. They agree with experimental results. For practical calculation of the coefficient of heat transfer, the following interpolation nula may be used:

$$N_{Nu} = 7 + 0{\cdot}05\, N_{Pr}{}^{0{\cdot}25}\, N_{Pe}{}^{0{\cdot}77}$$

h fits the calculated data with a maximum deviation of less than for $N_{Pr} < 0{\cdot}1$ and $N_{Pe} < 15\,000$. Limiting values of Nusselt ber as $N_{Pr} \to 0$ and $N_{Re} \to \infty$ were discussed.

18646 THERMAL CONTACT RESISTANCE BETWEEN MERCURY AND A METAL SURFACE.

izushina, S.Iuchi, T.Sasano and H.Tamura.

rnat. J. Heat Mass Transfer (GB), Vol. 1, No. 2-3, 139-46 ., 1960).

Reports an experimental analysis of the contact resistance in transfer between stagnant mercury and a solid metal surface. shown experimentally that there is a very small amount of act resistance between chromium-plated copper and pure cury.

8647 LOCAL AND AVERAGE HEAT TRANSFER COEFFICIENTS AT AN AIR STREAM IN A TUBE H A POINTED INLET. V.K.Ermolin.

rnat. J. Heat Mass Transfer (GB), Vol. 1, No. 2-3, 147-51 ., 1960).

Adduces experimental data on local and average coefficients eat transfer from air to the wall of a tube with a pointed inlet in range of Re numbers including a transient region.

8648 THE THEORY OF THERMAL REGULAR REGIME AND ITS APPLICATION TO THE DETERMINATION OF RMAL CHARACTERISTICS. G.N.Dulnev.

rnat. J. Heat. Mass Transfer (GB), Vol. 1, No. 2-3, 152-60 ., 1960).

The basic regularities of the thermal regular regime theory eloped by Condratjev and its practical application to motechnical measurements are discussed. The thermal ilar regime of a body or a system of bodies is understood to process of cooling or heating the system when: (1) the initial perature distribution in the system does not influence the law emperature change; (2) the law of temperature change is essed in a simple mathematical form; (3) this law is general for he points of the system. These regularities of the thermal ilar regime permitted: (a) a number of methods to determine thermal characteristics of different materials to be worked out; he thermal inertia of thermometers and pyrometers to be rmined; (c) the relations for calculating the kinetics of cooling eating the complicated thermotechnical apparatus and equipt to be obtained.

8649 APPLICATION OF VARIATIONAL METHODS TO THE THERMAL ENTRANCE REGION OF DUCTS.

.Sparrow and R.Siegel.

rnat. J. Heat Mass Transfer (GB), Vol. 1, No. 2-3, 161-72 ., 1960).

A variational method is presented for solving eigenvalue blems which arise in connection with the analysis of convective t transfer in the thermal entrance region of ducts. Considera- is given to both situations where the temperature profile ends upon one cross-sectional co-ordinate (e.g. circular tube) upon two cross-sectional co-ordinates (e.g. rectangular duct). The variational method is illustrated and verified by application to laminar heat transfer in a circular tube and a parallel-plate channel, and good agreement with existing numerical solutions is attained. Then, application is made to laminar heat transfer in a square duct; as a check, an alternate computation for the square duct is made using a method indicated by Millsaps and Pohlhausen [Heat transfer to Hagen-Poiseuille flows. Proceedings, Conference on Differential Equations, University of Maryland (1955)]. The variational method can, in principle, also be applied to problems in turbulent heat transfer.

18650 THE EFFECTS OF INTERNAL HEAT GENERATION ON HEAT TRANSFER IN THIN FINS.

W.S.Minkler and W.T.Rouleau.

Nuclear Sci. Engng (USA), Vol. 7, No. 5, 400-6 (May, 1960).

Some of the differential equations of thin fin theory have been rewritten to include an internal heat generation term, and solutions have been obtained for fins of rectangular, triangular, and "optimum" profiles. Fin temperature distributions and heat removal rates are exhibited as functions of the other variables involved by means of dimensionless parameters. In addition, criteria are discussed for determining whether the use of fins is worthwhile in a given application where internal heat generation is present in the fins. The analysis presented here should find wide application, not only to actual fins, but to many other problems where thin fin theory applies, such as determination of the heat transfer characteristics of thin structural members used in reactors.

18651 HEAT TRANSFER FROM LAMINAR FLOW THROUGH CYLINDRICAL TUBES. S.Pahor and J.Strnad.

Z. angew. Math. Phys. (Switzerland), Vol. 12, No. 1, 80-1 (Jan. 25, 1961).

The differential equation for heat transfer from laminar flow through cylindrical tubes is solved satisfactorily by means of confluent hypergeomagnetric functions. This method is of considerable practical interest owing to the recent efficient tabulation of these functions (see L.J.Slater, Confluent Hypergeomagnetric Functions, Cambridge, 1960). H.H.Hodgson

18652 A METHOD FOR THE NUMERICAL INTEGRATION OF THE ONE-DIMENSIONAL HEAT EQUATION USING CHEBYSHEV SERIES. D.Elliott.

Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 4, 823-32 (Oct., 1961).

A numerical solution of

$$\frac{\partial\theta}{\partial t} = \frac{\partial^2\theta}{\partial x^2}\ (-1 \le x \le 1;\ t > 0)$$

with general linear boundary conditions along $x = \pm 1$, is described where at any time t the Chebyshev expansion of $\theta(x, t)$ in $-1 \le x \le 1$ is computed directly. Compared with the more usual finite difference methods, this method requires much less computation and there are no stability problems. Two cases are considered in detail.

18653 GENERALIZED THERMAL RESISTANCE.

J.A.Lewis.

Quart. appl. Math. (USA), Vol. 19, No. 1, 76-80 (April, 1961).

The generalized thermal resistance is defined as the ratio of the average inlet—outlet temperature difference to the total heat power. It is shown that in the Neumann and Robin—Neumann problems, both with constant boundary values, the resistance may be expressed in terms of the Dirichlet integral, and upper and lower bounds for the resistance are obtained using Schwarz's inequality. In the Robin—Neumann problem the resistance is bounded below by the resistance for constant inlet and outlet temperatures, and above by the resistance for constant inlet and outlet heat flux.

S.Weintroub

18654 ANOMALY IN THE DISTRIBUTION OF TEMPERATURE IN THE SURFACE LAYERS OF A SOLID.

J.Jacq and M.Chateau.

C.R. Acad. Sci. (France), Vol. 252, No. 20, 3011-14 (May 15, 1961). In French.

The growth of temperature at the surfaces x = 0 (receiving a constant flux of heat) and x = e of a plane plate of thickness e is studied. The observed temperature of the surface x = 0 is much higher than that predicted by theory. Possible explanations of the experimental results are considered in the remarks made by Ribaud at the end of the paper. See also following two abstracts.

S.C.Jain

18655 ANOMALY IN THE DISTRIBUTION OF TEMPERATURE IN THE SURFACE LAYERS OF A SOLID AT A HEATED OR COOLED BOUNDARY. J.Jacq and M.Chateau.

C.R. Acad. Sci. (France), Vol. 252, 3201-3 (May 24, 1961).
In French.

It was shown in the preceding abstract that the temperature of the surface of a solid receiving a constant flux of heat F, rises to a value excessively high as compared to the theoretical value. The experimental and the theoretical values of the time after which the temperature variation with time becomes linear are compared and the experimental value is found to be very much more than the theoretical one. During this time the excess $\Delta\tau_c$ of the experimental temperature over that obtained theoretically obeys the relation

$$\Delta\tau_c(t) = \Delta\tau_{cm}\,[1 - e^{-t/\theta_c}]$$

and when the heating is stopped

$$\Delta\tau_c(t) = \Delta\tau_{cm}\,e^{-t/\theta_c},$$

where $\Delta\tau_{cm}$ is the maximum value of $\Delta\tau$, t is time and θ_c is a constant. The ratio K_c of $\Delta\tau_{cm}$ to the flux F is a constant and its value depends on the state of the surface and on the material. The value of θ_c is of the order of 2 sec, and varies little from specimen to specimen. During cooling, the corresponding constants K_r and θ_r are slightly smaller than those during heating. The constants are independent of the mode of heating or cooling. A correction involving the constants K_c and K_r in the expression for F, when the surfaces of the solid are in contact with a hot and cold liquid respectively, is given.

S.C.Jain

18656 ON THE DISTRIBUTION OF TEMPERATURES IN SOLIDS UNDER A FLUX OF HEAT. R.Lucas.

C.R. Acad. Sci. (France), Vol. 252, No. 26, 4132-4 (June 26, 1961).
In French.

In a previous note (Abstr. 7541 of 1961) it was shown that it was necessary to take into account the rediffusion of the thermal waves when there is a gradient of temperature in the solid due to a flux of heat F, received by its surface. The results obtained in that note are in qualitative agreement with the experimental observations of Jacq and Chateau (see the two preceding abstracts), which showed excessive rise of temperature of the surface of the solid receiving the flux. In the present note the quantitative expression for the excess of temperature δT due to rediffusion, over the value obtained by simple theory, is obtained and it is shown that δT is proportional to the flux F.

S.C.Jain

18657 STUDY OF FORCED CONVECTION BY AN OPTICAL PYROMETRY METHOD. J.Fauré.

Ann. Phys. (France), Vol. 5, No. 11-12, 1629-82 (Nov.-Dec., 1960).
In French.

A detailed description and discussion of the work described briefly in Abstr. 5207, 14870 of 1960.

S.Weintroub

18658 INVESTIGATION OF NATURAL CONVECTION HEAT TRANSFER IN LIQUID HELIUM.

J.S.McDonald and T.J.Connolly.

Nuclear sci. Engng (USA), Vol. 8, No. 5, 369-77 (Nov., 1960).

An experiment was performed to investigate the transfer of thermal energy by natural convection from molten sodium to a cold plate. A large tank of sodium was used to simulate a semi-infinite mass of sodium. A horizontal circular plate in intimate contact with the sodium surface was cooled by flowing tetralin which caused its temperature to be lower than the sodium bulk temperature. As a result, natural convection occurred in the sodium and thermal energy was transferred from the sodium to the plate. Data were collected at steady-state conditions for values of the Rayleigh number ranging from 4.8×10^5 to 4×10^7. It was found that the experimental results could be correlated by the expression $Nu = 0.0785\,Ra^{0.32}$, where Nu is the Nusselt number, and Ra is the Rayleigh number. The calculated probable error in the Nusselt number given by the above equation is 1.08, and the multiple correlation coefficient for the experimental results and the equation is 0.954. The foregoing result is shown to be consistent with the results of other investigators who used different fluids in physica systems somewhat similar to that used in this experiment with sodium.

18659 A BLACKBODY MODEL OPERABLE AT HIGH TEMPERATURE. G.F.Sitnik.

Astron. Zh. (USSR), Vol. 37, No. 6, 1076-86 (Nov.-Dec., 1960).
In Russian.

A tube model of a blackbody made of graphite is described This model reproduces equilibrium radiation at different tempe tures with a precision to 0.1%, thus exceeding considerably the precision of modern absolute measurements of radiative energ It is proved theoretically and experimentally that such a precisi of reproducing equilibrium radiation is obtained for temperatur gradients along the axis of the tube of the order of 3 deg cm^{-1}. The blackbody model was made on the basis of the high tempera ture King-type modified furnace, the heating element of which i essentially altered. The graphite heating tube with a variable w thickness was experimentally selected so as to provide for a uniform temperature with the above precision at the middle pa of the tube (length 70 mm, the total length of the heated part bei 170 mm). The suitability of the tube for each selected alternati current was determined at equilibrium operating conditions on t basis of two requirements: (1) The minimal difference of tempe ture at three points, determined by means of two differential tungsten—tantalum thermocouples specially made and investigat for this purpose. (2) The disappearance of ceramics, junctions wires of the thermocouples on the background of the heated con tinuous surface of the cavity of the blackbody. This together wi the first requirement showed that equilibrium conditions were attained. The heating tubes were selected for different tempera from 1336° to 2700°K. The cavity of the blackbody, 40 mm in le with a diaphragm aperture of 4 mm (together with the necessary set of diaphragms) was located in the middle part (70 mm) with uniform temperature. The cavity of the blackbody is a part of th graphite radiating tube of the furnace, which is inside the heatin tube and has no electric contact with it. [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 6, 1013-22 (May-June, 196

18660 REMARK ON THE DERIVATION OF KIRCHHOFF'S LAW. C.v.Fragstein.

Optik (Germany), Vol. 18, No. 6, 264-6 (June, 1961). In German

A usual derivation (for example Planck's method), which assumes that the media have only moderate absorption, is gener ized to the case of strongly absorbing media. At the same time, is pointed out that the specific radiation intensity as defined by Planck, in an absorbing medium at constant temperature, is inversely proportional to its absorption coefficient k.

18661 A PROCEDURE FOR SIMPLIFIED EVALUATION OF THE PLANCK RADIATION LAW. M.Czerny.

Optik (Germany), Vol. 17, No. 12, 671-7 (Dec., 1960). In German

A graphical method is given which enables an integral of the form

$$\int_{\lambda_2}^{\lambda_1} E(\lambda,T)\,D(\lambda)d\lambda \quad \text{or} \quad \int_{\lambda_1}^{\lambda_2} E(\lambda,T)\,V(\lambda)\,D(\lambda)d\lambda$$

to be evaluated rapidly and in a readily understandable manner. $E(\lambda,T)$ is the well-known function expressing the Planck radiatio law, T the absolute temperature of the radiator, $D(\lambda)$ the spectra transmission distribution of any given colour filter, and $V(\lambda)$ the spectral sensitivity curve of the eye. The first integral is neces ary if information is required concerning the radiation current passed by the filter glass, the second if information is required about the brightness impression on the eye resulting from this ra ation current.

18662 COMPENSATING RADIOMETER.

A.R.King.

Brit. J. appl. Phys., Vol. 12, No. 11, 633-4 (Nov., 1961).

A radiometer for the measurement of near infrared radiatio in fire research is described. The novel features of the instrum are robustness, ability to withstand immersion in flames and the absence of windows.

18663 AN ABSOLUTE THERMAL RADIATION CALORIMETER. J.H.McGuire.

Canad. J. Phys., Vol. 39, No. 11, 1583-94 (Nov., 1961).

To allow the absolute calibration of field and laboratory radi meters in the range 0.1 to 1.5 cal cm^{-2} sec^{-1}, a continuous flow

tion calorimeter has been constructed, based on a design
nally developed by the British Joint Fire Research Organization.
emperature difference established between a water outlet and
let is sensed by a thermistor bridge and the radiation intensity
surement is made in terms of the level of the electrical power,
ed to a built-in immersion heater, which is necessary to
oduce the same temperature difference.

664 INTERACTION OF A WEAK ENTROPY WAVE WITH THE FRONT OF A FLAME.

ovikov and Yu.S.Ryazantsev.
. Akad. Nauk SSSR, Vol. 139, No. 5, 1157-8 (Aug. 11, 1961).
ssian.
This short theoretical note considers the interaction of the
. of a flame with an entropy wave, in a combustible mixture of
s. Simplifying assumptions made are: (1) that the wave is weak,
2) that the velocity of propagation of the flame is small
ared with that of sound. Expressions are calculated for:
e pressure wave in the combustible mixture, (2) the pressure
in the combustion products, and (3) the entropy wave in the
ustion products. N.Davy

665 A STUDY OF THE AMPLIFICATION OF COMPRESSION WAVES DURING COMBUSTION.

Kogarko and D.L.Ryzhkov.
ekh. Fiz. (USSR), Vol. 31, No. 2, 211-16 (Feb., 1961).
ssian.
Reports studies of the dependence of pressure on time during
ustion in a closed volume for different fuel—air enriched oxygen
ures. Sample oscillograms from a piezoelectric quartz are
n. Some traces show a smooth increase of pressure (as
ally expected), but others have oscillations superimposed. The
itudes of the oscillations increase up to the end of the
lograms. The amplification factor K^2 is defined as the ratio of
ucceeding wave amplitude to the preceding one. Plots of K^2
st the composition of mixture (α), with different oxygen
entages as a parameter, indicate that K^2 increases with higher
en content (for $0.65 < \alpha < 0.75$). Furthermore, higher initial
sures ($\sim$ 600 mm Hg) also favour amplification of the oscill-
s. At 300 mm Hg and less, no oscillations are observed. An
nation for these phenomena is sought in the disturbances
pression waves) which originate in the combustion process.
e waves are reflected and intersect the flame front many times.
ever the compression wave passes through the combustion zone,
ger amount of energy is released there than in the undisturbed
e. Therefore, any perturbation passing through the flame front
apable of increasing the speed of the chemical reaction, will
f be amplified. [English translation in: Soviet Physics—
nical Physics (USA), Vol. 6, No. 2, 151-5 (Aug., 1961)].
C.B.Ludwig

8666 INTERNATIONAL PRACTICAL TEMPERATURE SCALE OF 1948. TEXT REVISION OF 1960.

Stimson.
Bur. Stand. (USA), Monogr. No. 37, 1-7 (1961).
The scale is a text revision of the International Temperature
e of 1948, the numerical values of temperatures remaining the
e. The adjective "Practical" was added to the name by the
national Committee on Weights and Measures. The scale
inues to be based upon six fixed and reproducible equilibrium
eratures to which values have been assigned, and upon the same
polation formula relating temperatures to the indications of
ified measuring instruments. Some changes have been made in
ext to make the scale more reproducible than its predecessor.
triple point of water, with the value 0.01°C replaces the former
oint as a defining fixed point of the scale. It is also recommended
the zinc point, with the value 419.505°C, be used instead of the
hur point. The recommendations include new information that
become available since 1948.

8667 OPTICAL METHOD FOR THE DIRECT DETERMINATION OF THE TRUE TEMPERATURE OF GLOWING

ALS. C.Tingwaldt and U.Schley.
strumKde (Germany), Vol. 69, No. 7, 205-7 (July, 1961).
erman.
Determines the thermodynamic temperature by means of an
cal pyrometer equipped with a polarizer, the line of sight
king the surface at 45°.

18668 A RADIO-FREQUENCY RESISTANCE THERMOMETER.

F.Nagao, S.Ohigashi and I.Higashino.
Bull. J.S.M.E. (Japan), Vol. 4, 340-6 (May, 1961).

A sensitive thermometer with fast response is studied which utilizes the "skin-effect" and "resonance". A fine platinum wire (0.08 mm diameter) fed with a 7 Mc/s current shows a character superior to the one which is obtained by the customary method. The device has the advantage that it can be applied without decreasing the response and the sensitivity, even if a thick wire is used to obtain better mechanical strength. As a result, it will be useful for measuring transient temperature changes, for instance, a hot gas in the cylinders of internal combustion engines and other similar machines.

18669 HIGH TEMPERATURE INDUCTION FURNACES.

P.H.Dundas.
Research (GB), Vol. 14, No. 7, 262-8 (July, 1961).

The design of laboratory high temperature induction furnaces is treated from both theoretical and practical aspects. An attempt is made to simplify an otherwise complex electrical engineering analysis so that the research physicist can avoid wasting much time and energy over trial and error methods when faced with high temperature problems that can be satisfied only by the use of induction heating. This article is intended to give a new approach to the use of induction heating as an important high temperature tool.

18670 MEASUREMENTS OF TRUE SPECIFIC HEATS BY THE CALVET MICROCALORIMETER.

E.Calvet and C.Dutheil.
C.R. Acad. Sci. (France), Vol. 253, No. 11, 1207-9 (Sept. 11, 1961).
In French.

Liquid and solid specimens were chilled by the Peltier effect in the title microcalorimeter, and measurements were made of the lowering of temperature and of the thermal changes involved during application of the effect and on its withdrawal. From thermograms, which are readily reproduced, connecting temperature and thermal effects, accurate specific heats may be calculated.

H.H.Hodgson

CHANGE OF STATE

(Solid-state phase transformations are included primarily under Structure of Solids)

18671 CRITIQUE OF THE CLUSTER THEORY OF CRITICAL POINT DENSITY FLUCTUATIONS.

F.H.Stillinger, Jr and H.L.Frisch.
Physica (Netherlands), Vol. 27, No. 8, 751-2 (Aug., 1961).

From a consideration of cluster theory the conclusion is drawn that highly connected clusters must be considered in obtaining a proper description of at least the critical point, if not the condensed phase. It therefore appears fundamentally necessary to look for a renormalization of the terms in the expansion series such that the series continue to converge in the region where the cooperative transition takes place. D.ter Haar

18672 THE SHAPE OF THE CRITICAL ISOTHERM NEAR THE CRITICAL POINT.

A.V.Voronel'.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1516-18 (May, 1961).
In Russian.

The quantity $B = (d^3p/dV^3)_{T_c}$, which characterizes the shape of the critical isotherm near the critical point terminating the liquid—gas equilibrium, is calculated for five simple substances and water. Coincidence of the results obtained by four different methods indicates that $B < 0$ for simple liquids and that this quantity can be reliably estimated. It is shown that for simple substances the approximate values can be derived from the known values of the critical parameters p_c and V_c. [English translation in: Soviet Physics—JETP (USA)].

18673 GAS—LIQUID PHASE EQUILIBRIUM IN THE SYSTEM NH_3—A.

A.Michels, E.Dumoulin and J.J.T. van Dijk.
Physica (Netherlands), Vol. 27, No. 9, 886-92 (Sept., 1961).

In a previous publication (Abstr. 3852 of 1951) an instrument has been described for study, under elevated pressure, of the gas–liquid phase equilibrium of a two-component system. Here the results obtained with the system NH_3–A are given. The equilibrium was determined at 25, 50, 75 and 100°C and pressures up to 800 atm. The results are represented in diagrams giving the isotherms in the P–x projection, the isobars in the t–x projection and the lines of constant concentration in a P–t projection.

18674 FIRST AND SECOND ORDER TRANSITIONS IN LIQUID BINARY MIXTURES.

R.De Bruyn Ouboter and J.J.M.Beenakker.
Physica (Netherlands), Vol. 27, No. 11, 1074-82 (Nov., 1961).

It appears to be a general property that the first order equilibrium curves for liquid binary mixtures show a singularity at the junction with the second order lambda curve as can be seen on the basis of pure thermodynamic consideration. Thermodynamic relations are derived for the discontinuity in the slope of the boiling-, freezing- and stratification curve at the junction with the lambda curve.

18675 THE PREDICTION OF STEAM VOLUME FRACTIONS IN BOILING SYSTEMS.

J.F.Marchaterre and M.Petrick.
Nuclear Sci. Engng (USA), Vol. 7, No. 6, 525-32 (June, 1960).

The results of an extensive study of the relative velocity of two-phase mixtures are presented. The parameter ranges studied are pressure 150-2000 lb/in²., mixture quality 0-0.25, superficial liquid velocity 0.5-8 ft/sec, and flow channel equivalent diameters of 0.4-2 in. The data were correlated by means of the velocity ratio (steam velocity/liquid velocity) which was calculated from the measured steam volume fraction. The steam volume fraction measurements were made by a radiation attenuation technique and the data were obtained from both adiabatic and nonadiabatic systems. The data show that the velocity ratio is affected primarily by pressure, mixture quality, superficial velocity, and to a lesser degree by the flow channel geometry. The data are also compared with the data of other investigators for the vertical up-flow of steam-water mixtures. Working curves for the prediction of the velocity ratio are then presented which are adequate for system analyses. The working curves are given for 150, 250, 400, and 600 lb/in². A method of extrapolating the data for predicting working curves in the high-pressure range is suggested.

18676 ON THE CORRELATION OF NUCLEATE BOILING HEAT TRANSFER. K.Nishikawa and K.Yamagata.

Internat. J. Heat Mass Transfer (GB), Vol. 1, No. 2-3, 219-35 (Aug., 1960).

A generalized equation to describe nucleate boiling is derived. The expression which correlates all fluid independently of pressure and heating surface-fluid combination is as follows:

$$Y = 8.0(f_{\zeta}{}^{1/2} f_p X)^{2/3}$$

where

$$X = \left(\frac{1}{M^2 P}\,\frac{c_p \gamma'^2}{\lambda \sigma r \gamma''}\right)^{1/2} R^{3/2} q$$

$$Y = \frac{\alpha R}{\lambda}$$

and c_p = specific heat of liquid; γ' and γ'' = specific weight of liquid and vapour; λ = thermal conductivity of liquid; σ = surface tension of liquid; R = the representative length of heating surface; q = heat flux; α = coefficient of heat transfer; M = 900 m^{-1}, P = 1.699 kcal/hr. f_{ζ} = foamability, and f_p = pressure factor. Furthermore, it is indicated that this correlating equation is applicable to forced-convection saturated or surface boiling. The proposed correlating equation is theoretically sought by analysing the elementary processes of phenomena, but it is not based on dimensional analysis. In order to reach the final solution of the problem, it is necessary to analyse the elementary processes of boiling phenomena and elucidate the relations underlying the problem.

18677 CRYOSCOPIC EFFECT OF SEPARATION AND CONCENTRATION OF SOLUTES. K.S.Rangappa.

Nature (GB), Vol. 191, 1087-8 (Sept. 9, 1961).

To obtain a three-dimensional picture, the concentrations of annular layers and vertical portions of frozen columns of solutions of $CuSO_4$, $KMnO_4$, $K_4Fe(CN)_6$, and skim milk were analysed. The results afford an insight into the pattern of concentration on freezing, the heaviest concentration appearing to be a hollow ring at the botto the column. In particular, the KM_nO_4 frozen column exhibits a v concentration gradient of the salt in the form of a purple cone wi base at the bottom, and this may be typical of the cryoscopic co centration of solutes. H.H.Hod

18678 MELTING AND POLYMORPHISM OF INDIUM ANTIMONIDE AT HIGH PRESSURES.

A.Jayaraman, R.C.Newton and G.C.Kennedy.
Nature (GB), Vol. 191, 1288-90 (Sept. 23, 1961).

From the variation of the melting point of InSb with pressu latent heat of fusion of 49.0 cal/g, which is in good agreement w the experimental value of 47.2 cal/g reported by Gebbie, Smith, Austin and King (Abstr. 6160 of 1961), was obtained. The solid–solid boundary was found to intersect the melting curve at 335° and 19.4 kb and the transition from one solid phase to another w analogous to that occurring between grey and white tin where a change from semiconduction to metallic conduction is accompan by a large reduction in volume. G.C.Willi

18679 SYMMETRY OF MOLECULES, MELTING OF CRYS AND ORDERING OF LIQUIDS. Ya.B.Zel'dovich.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 4, 841-3 (Aug. 1, 1961). In Ru

Among different crystalline isomers, the one having the mo symmetrical structure will have the highest melting point; no quantitative relationship between these parameters has been est lished as other factors also affect the melting point. On the bas of a simplified model an equation was derived but it only gives t sign and the order of magnitude of the difference between the me ing points of the isomers. The effect of the symmetry of the molecule is smaller than the theoretically calculated if the cryst is not completely ordered or if the liquid isomer retains some degree of ordering; this effect is larger than the calculated if th energy of the crystals and the liquid are affected by both the stru ture and the entropy. [English translation in: Soviet Physics—Doklady (USA)]. A.Avr

THE THEORY OF THE LIQUID STATE. See Abstr. 18393

THERMODYNAMICS

(See also Statistical Mechanics)

18680 THERMODYNAMICS OF TURBULENT SYSTEMS.

V.G.Nevzglyadov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1727-33 (Dec., 196 In Russian.

Some consequences of the second law of thermodynamics for single-component turbulent systems are derived. It is shown tha the second law must be generalized in order to be applicable to turbulent systems. This is done by means of the concept of "turbulent-thermal entropy". [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1206-10 (June, 1961)].

18681 THE JOULE–THOMSON EFFECT.

W.Koeppe.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 71-8 (1960). In German.

A largely thermodynamic theory of the Joule–Thomson effec for gases and mixtures of gases is presented. Comparisons with experiment are satisfactory. See also following abstract. P.T.Landsbe

18682 SHAPE OF THE INVERSION CURVE FOR LOW TEMPERATURES. W.Koeppe.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 78-86 (1960). In German.

The inversion curve is the curve in a pressure–temperature diagram which separates the region of positive differential Joule–Thomson effect from the region for which the effect is negative. The connection with the vapour-pressure curve is discussed thermodynamically. P.T.Landsbe

LOW-TEMPERATURE PHYSICS

8683 LOW TEMPERATURE HEAT EXCHANGERS.
A.G.Lenfestey.
ress in cryogenics, Vol. 3 (see Abstr. 13029 of 1961) p. 23-47.

The design of secondary surface heat exchangers, constructed dip-brazed aluminium alloy, is reviewed. Constructional ods, mechanical design and performance are discussed, and emperature applications as gas—gas and liquid—gas heat angers and as condenser-reboilers are described. J.B.Birks

584 NOVEL REFRIGERATION CYCLES AND DEVICES.
W.E.Gifford.
ress in cryogenics, Vol. 3 (see Abstr. 13029 of 1961) p. 49-73.

Describes two new refrigeration cycles that appear to be cularly applicable to the design of small simple refrigerators. first cycle involves operation of an expansion engine with an ient small thermal regenerator between the expansion space he engine valves, and it has been embodied in a pencil-size refrigerator. The second cycle, described as a low tempera- heat pump, has been applied in a helium liquefier. J.B.Birks

8685 MINIATURE CRYOSTAT FOR MEASUREMENTS ON FERROMAGNETICS BETWEEN 1.6 AND 300°K.
Scott and J.Crangle.
ci. Instrum. (GB), Vol. 38, No. 11, 436-8 (Nov., 1961).

The cryostat requires external supplies of the liquids helium, ogen and nitrogen. It operates within a working width of 19 mm e specimen position, and the vertical height from specimen to s 20 cm. It is used with the Sucksmith ring balance. Very dy specimen temperatures are possible throughout the range to 300°K, and it is economical to operate.

quid and Solid Helium

8686 HELIUM LIQUEFIERS.
A.J.Croft.
gress in cryogenics, Vol. 3 (see Abstr. 13029 of 1961) p. 1-21.

After a short discussion of the principles of helium liquefaction, construction, operation and performance of three proprietary efiers (Collins, Meissner, Weil) and of several major and small ratory-made liquefiers are described. 45 references, several iled diagrams and photographs. J.B.Birks

8687 INELASTIC SCATTERING OF NEUTRONS FROM ROTATING LIQUID HELIUM II. A.D.B.Woods.
ad. J. Phys., Vol. 39, No. 7, 1082-4 (July, 1961).

A beam of 4.06 A neutrons was scattered from liquid helium ough an angle of $81\frac{1}{4}°$ and the inelastically scattered neutrons rgy-analysed. At 1.5°K, no difference was observed between results for stationary helium and for helium rotating at rev/min. O.Penrose

8688 SPECIFIC HEAT AND EXPANSION COEFFICIENT OF LIQUID HELIUM-3 UNDER PRESSURE BELOW K. D.F.Brewer and J.R.G.Keyston.
ure (GB), Vol. 191, 1261-3 (Sept. 23, 1961).

Recent measurements of the specific heat of liquid He^3 near saturation pressure (Abstr. 8276-7 of 1961) have shown that the ond-order phase transition predicted by theory (Abstr. 11124, 48 of 1960) does not occur above 0.008°K. According to Emery Sessler (Abstr. 12548 of 1960) the transition temperature T_c iven by

$$kT_c = 1.09\,\frac{\hbar k_F^2}{m^*}\,\frac{m}{m^*}\,\exp\left(-\frac{\pi}{2}\,\frac{m}{m^*}\,\frac{1}{t}\right),$$

ere $\hbar k_F$ is the Fermi momentum and m^*/m the ratio of the ective mass to the true mass of the He^3 atom. The effective mass roportional to the specific heat at low temperatures, where the er has linear temperature dependence. The multiplier $1/t$ is a erical factor of the order of 5.5, giving $T_c = 0.1°$ at the vapour ssure. An increase in m^* will raise the transition temperature. evious specific heat measurements down to 0.12°K (Abstr. 223-4 960) have shown that m^* increases considerably with pressure. These measurements reported in the present paper were extended down to 0.04°K at pressures of 26.6 atm, 11.5 atm and 15 cm Hg. Again, there is no indication of any anomaly in the specific heat which decreases smoothly with decreasing temperature, tending to a linear dependence at the lowest temperatures. At 26.6 atm the effective mass is found to be 1.78 times greater than at the vapour pressure. This should raise T_c in the above equation by a factor 3.2. Measurement of the change in temperature on adibatic expansion and compression of the liquid at average pressures of 25.2 and 26.9 atm, i.e. near the melting pressure, gave a negative value for Δ_T/Δ_p in the entire range from 0.04 to 0.32°K. This means that the expansion coefficient at constant pressure, α_p, is always negative. This observation does not fit in readily with the result of Mills et al. (Abstr. 4526 of 1961), who conclude that $\alpha_p = 0$ at the minimum in the melting curve (0.32-0.34°K and about 29 atm). H.London

18689 PHASE SEPARATION IN He^3—He^4 MIXTURES NEAR ABSOLUTE ZERO. D.O.Edwards and J.G.Daunt.
Phys. Rev. (USA), Vol. 124, No. 3, 640-2 (Nov. 1, 1961).

Phase separation in liquid mixtures of He^3 and He^4 at temperatures close to 0°K is discussed on the basis of the isotopic impurity models of Pomeranchuk (1949) and Zharkov and Silin (Abstr. 8863 of 1960). It is predicted that for He^3-rich mixtures the phase separation line is asymptotic to the temperature axis as $T \to 0$, so that phase separation should occur in extremely dilute solutions of He^4 in He^3 at relatively high temperatures. For example 0.003% of He^4 in liquid He^3 should begin to separate at about 0.1°K. The phase separation curve for He^4-rich mixtures near 0°K is difficult to predict with the data available at present. One possibility is that dilute solutions of He^3 in He^4 may be stable at 0°K.

18690 DENSITY OF LIQUID HELIUM-3 BETWEEN 0.045 AND 1.3°K. J.E.Rives and H.Meyer.
Phys. Rev. Letters (USA), Vol. 7, No. 6, 217-19 (Sept. 15, 1961).

The density of liquid He^3 was measured at various pressures up to 28.0 atm in the temperature range between 0.045° and 1.3°K. At pressures above about 15 atm an unexpected minimum in density found to occur, the temperature of this minimum increasing to 0.09°K when the pressure was increased to 28 atm. For a pressure of 0.18 atm and below 0.08°K, the coefficient of expansion was $\alpha_p = -(0.12 \pm 0.02)\,T$ in qualitative agreement with Brueckner's theory, which predicts $\alpha_p = -0.076\,T$. H.London

18691 SELF-DIFFUSION COEFFICIENT AND NUCLEAR SUSCEPTIBILITY OF LIQUID HELIUM-THREE.
A.C.Anderson, W.Reese, R.J.Sarwinski and J.C.Wheatley.
Phys. Rev. Letters (USA), Vol. 7, No. 6, 220-2 (Sept. 15, 1961).

Extension of the measurements of Abstr. 19542 of 1960 to lower temperatures (0.022°K) with improved accuracy. For $T < 0.04°K$, the diffusion coefficient follows the T^{-2} law expected from theory (Abstr. 2918 of 1961):

$$D = (1.54 \pm 0.1) \times 10^{-6}\,(T.\mathrm{deg\,K})^{-2 \pm 0.02}\ \mathrm{cm^2\,sec^{-1}}.$$

This brings these measurements in line with recent measurements of the specific heat (Abstr. 8276 of 1961) and of the thermal conductivity (Abstr. 11871 of 1961). The resulting empirical value of the relaxation time for diffusion is

$$\tau_D = 4.6 \times 10^{-13}\,T^{-2}\ \mathrm{sec\,(deg\,K)^2}.$$

This is to be compared with $\tau_K = 6.4 \times 10^{-13}\,T^{-2}$ obtained from the above conductivity measurements and with $\tau_D = 1 \times 10^{-13}\,T^{-2}$ resulting from theory. Below 0.4°K the two former relaxation times give values for the ratio of the uncertainty in quasi-particle energy to kT, i.e. $h/\tau kT$ less than one. The susceptibility χ remains constant in the whole range below 0.1°K, in quantitative agreement with the previous paper. In terms of the effective magnetic temperature

$$T^* = (\chi T)[1.153°K]/\chi$$

this constant value of χ gives $T^* = (0.347 \pm 0.010)°K$. From all this collected evidence it is concluded that the concept of helium-3 as a Fermi liquid at temperatures of less than 0.04°K and at low pressures is valid. H.London

18692 THEORY OF THE KAPITZA THERMAL DISCONTINUITY OF THE BOUNDARY BETWEEN LIQUID He^3 AND A SOLID BODY. I.L.Bekarevich and I.M.Khalatnikov.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1699-1712 (Dec., 1960). In Russian.

The problem of motion in a Fermi liquid due to vibrations of the boundary is treated. The energy transferred to the liquid during thermal vibrations of the solid body and the related heat transfer at various temperatures of the liquid and the solid are computed by applying the resulting solutions. The thermal resistance derived is proportional to T^{-3}. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1187-95 (June, 1961)].

18693 CONTRIBUTION TO THE STUDY OF THE AGREGATION OF HELIUM FROM MEASUREMENTS OF THE SPECIFIC HEAT OF IRRADIATED BERYLLIUM OXIDE.

J.Aslanian, R.Caillat, M.Salesse and L.Weil.
C.R. Acad. Sci. (France), Vol. 253, No. 8, 1032-3 (Aug. 21, 1961). In French.

Neutron irradiation of beryllium oxide gives rise to the formation of helium. The specific heat of an irradiated specimen was measured in the temperature range 1·3 to 3·7°K. After irradiation, but before annealing, the specific heat shows no significant change. Annealing for 24 hr at 600°C produces an anomaly in the specific heat around 2°K which is more pronounced after a further 24 hr anneal at 900°C. After annealing for 24 hr at 1200°C the specific heat shows the same type of anomaly as that associated with the λ transition of helium. This behaviour is consistent with the transformation from a non-saturated film to the properties of a macroscopic volume of helium. F.E.Hoare

18694 MAGNETO-RESISTANCE IN SUPERFLUID LIQUID HELIUM.

G.Severne.
Physica (Netherlands), Vol. 27, No. 5, 465-78 (May, 1961).

Deals with the approach towards equilibrium of a system consisting of a weak concentration of ions in a gas of hard Bose spheres at absolute zero placed in a uniform magnetic field. The magnetoresistance effect which appears is remarkable, as the zero field resistance of this system is zero; the field does not modify an existing diffusion mechanism, it rather creates one. The complete evaluation of the relaxation time of the system yields a dependence inversely proportional to the cube of the magnetic field. H.London

18695 PHENOMENOLOGICAL DERIVATION OF THE EQUATIONS OF VORTEX MOTION IN He II.

I.L.Bekarevich and I.M.Khalatnikov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 920-5 (March, 1961). In Russian.

A phenomenological derivation, based upon conservation laws, of the equations of vortex motion is presented, with dissipative processes taken into account. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 643-6 (Sept., 1961)].

SCATTERING OF γ-RAYS IN LIQUID He^3. See Abstr. 16735

18696 VORTEX LINES IN AN IMPERFECT BOSE GAS.

L.P.Pitaevskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 646-51 (Feb., 1961). In Russian.

It is shown that the vortex lines possessing a thickness which is inversely proportional to the square root of the gas density and of the intensity of the interaction may exist in Bose gases with weak repulsion between the atoms. The energy of a vortex line is computed. It is also shown that in the presence of a vortex line a branch appears in the energy spectrum of the gas which corresponds to oscillations of the vortex. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 451-4 (Aug., 1961)].

18697 SUPERFLUIDITY IN A FERMI SYSTEM IN THE PRESENCE OF PAIRS WITH NON-ZERO ANGULAR MOMENTUM.

L.P.Gor'kov and V.M.Galitskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1124-7 (April, 1961). In Russian.

A picture is proposed for the superfluid state in a Fermi system when the Cooper pairs have a non-zero angular momentum. It is shown that if the system does not have a total angular momentum, the ground state will be isotropic. The Fermi excitation spectrum has its usual form with an isotropic gap. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 792-4 (Oct., 1961)].

18698 A CONTRIBUTION TO THE THEORY OF SUPERFLUIDITY IN AN IMPERFECT FERMI GAS.

L.P.Gor'kov and T.K.Melik-Barkhudarov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1452-8 (May, 1961 In Russian.

The Cooper effect (Abstr. 2255 of 1957) is studied in a low-density Fermi gas. The transition temperature to the superfluid state is determined. [English translation in: Soviet Physics—JE (USA)].

Superconductivity

18699 THEORY OF MANY-PARTICLE SYSTEMS. II. SUPERCONDUCTIVITY.

L.P.Kadanoff and P.C.Martin.
Phys. Rev. (USA), Vol. 124, No. 3, 670-97 (Nov. 1, 1961).

A fermion system with a simple attractive interaction is discussed with the aid of time-dependent correlation functions. Although perturbation theory is inapplicable, a sequence of corre tion approximations described in Pt I (Abstr. 896 of 1960) can be employed. The lowest approximation in the sequence expresses t two-particle correlation function in terms of single-particle functions and leads to the Hartree approximation; the second expresses three-particle correlation functions in terms of one- a two-particle correlation functions and leads to the time-dependen correlation functions that characterize the super-conducting mode of Bardeen, Cooper and Schrieffer. These correlation functions a determined and the thermodynamic properties of the superconduc are calculated from them. The electromagnetic effects of the sup conductor predicted by the Bardeen—Cooper—Schrieffer time-dependent correlation functions are considered. Their unsatisfact description of current conservation is indicated and overcome by more accurate solution valid at nonvanishing temperature. This solution predicts different diffusive properties but the same Meissner effect and superconductive behaviour, since the longitudin current correlation function is modified while the transverse current correlation function is not. The final section of the paper devoted to the properties of a pure superconductor which depend o the lifetimes of the single-particle excitations. The effect of thes lifetimes on the static electrical conductivity is determined, and i is shown that they do not destroy supercurrents although they eliminate a gap in the single-particle excitation spectrum. Their effect on the thermal conductivity is also calculated using heat current correlation functions. It is shown that a model which trea the lifetime of the single-particle excitation due to lattice interactions as constant yields results in agreement with observed thermal conductivities.

18700 ENHANCEMENT OF SUPERCONDUCTIVITY BY EXTRACTION OF NORMAL CARRIERS.

R.H.Parmenter.
Phys. Rev. Letters (USA), Vol. 7, No. 7, 274-7 (Oct. 1, 1961).

It is suggested that the transition temperature T_c of a superconductor can be raised by extracting normal (unpaired) electron and holes as soon as they are formed. This can be done by using sandwich of the form BDADB, where D is dielectric and A, B are different superconductors, with $T_c(B) > T_c(A)$. Application of a bias voltage will extract normal electrons from A by tunnel effect on one side, and holes on the other side, and $T_c(A)$ should be rais towards $T_c(B)$. Still larger bias should depress $T_c(A)$. Estimate generation and extraction rates suggest that film A needs to be ~ 100 A thick. R.G.Chambe

18701 THERMODYNAMICS OF ANISOTROPIC SUPERCONDUCTORS.

V.L.Pokrovskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 641-5 (Feb., 1961). In Russian.

The Bogolyubov equation for the energy gap is solved for the anisotropic case. It is shown that in the weak coupling approxima tion a change in temperature leads to a change in the magnitude o the gap by a factor which is independent of the direction. The general behaviour of the change in the thermodynamic quantities i qualitatively the same as in the isotropic case. The relative jum in the specific heat turns out to be larger than 1.4. An inequality the same kind is also obtained for the critical magnetic field near absolute zero. [English translation in: Soviet Physics—JETP (U Vol. 13, No. 2, 447-50 (Aug., 1961)].

8702 ABSORPTION OF ULTRASOUND IN AN ANISOTROPIC SUPERCONDUCTOR. V.L.Pokrovskii.
:ksper. teor. Fiz. (USSR), Vol. 40, No. 3, 898-906 (March, 1961).
ıssian.

Anisotropy of superconductors is taken into account within the ıework of the Gor'kov method (Abstr. 7982 of 1958). The tron—phonon interaction is not considered small, but the small- of the sound velocity in comparison with the Fermi velocity plicitly taken into account. It is shown that the low-temperature on $T \ll T_c$ is divided into two regions in which the behaviour of sound attenuation as a function of direction and temperature is ificantly different. Sound absorption exhibits some peculiarities w temperatures in semiconductors possessing Fermi surfaces of "corrugated" type. The problem of the possibility of determining energy gap from data on the attenuation of ultrasound is analysed. glish translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, -33 (Sept., 1961)].

8703 RECONSTRUCTION OF THE ENERGY GAP IN A SUPERCONDUCTOR BY MEASUREMENT OF SOUND TENUATION. V.L.Pokrovskii and V.A.Toponogov.
eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1112-14 (April, 1961).
ussian.

A method is indicated for the reconstruction of the energy gap as a function of direction in an anisotropic superconductor on basis of measurements of sound absorption $\alpha(n)$ in the low- perature region. The method is based on the simple relation veen the level lines of $\Delta(n)$ and $\alpha(n)$ on the stereographic jection of the Fermi surface. [English translation in: Soviet sics—JETP (USA), Vol. 13, No. 4, 785-6 (Oct., 1961)].

18704 MAGNETIC FIELD DEPENDENCE OF THE SUPERCONDUCTING PENETRATION DEPTH IN THIN CIMENS. D.H.Douglass, Jr.
s. Rev. (USA), Vol. 124, No. 3, 735-9 (Nov. 1, 1961).

The magnetic field dependence of the penetration depth for very films as predicted by the Ginzburg—Landau theory (Abstr. 1017 952) is considered. The results obtained depend upon the ndary conditions on the film. For the usual case of equal gnetic fields on opposite sides of the film, the penetration depth reases smoothly toward infinity as the critical field is approached, responding to a second-order phase transition. For the less mon case of unequal fields on opposite sides, the penetration th increases toward a finite value as the critical field is roached, corresponding to a first-order phase transition. The ults for the latter case are shown to agree remarkably well with very precise experiments of Garwin, Erlbach and Sarachik str. 10853 of 1960) on the field dependence of the penetration th of a 250 A film of Pb. The penetration depth in zero field as nction of thickness is also considered.

18705 TEMPERATURE GREEN'S FUNCTION FOR ELECTRONS IN A SUPERCONDUCTOR. G.M.Éliashberg.
eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1437-41 (Nov., 0). In Russian.

The temperature Green's function is computed by the diagram hnique for $T \neq 0$. An estimate is made of the region near the tical temperature for which the usual analysis, which makes use temperature-dependent gap in the excitation spectrum, is no ger valid. The magnitude of this temperature range is of the ler of $(2\Delta(0)/\omega_0)^4 T_c$. [English translation in: Soviet Physics— TP (USA), Vol. 12, No. 5, 1000-2 (May, 1961)].

18706 CONTRIBUTION TO THE THEORY OF SUPERCONDUCTING ALLOYS WITH PARAMAGNETIC PURITIES. A.A.Abrikosov and L.P.Gor'kov.
eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1781-96 (Dec., 1960).
Russian.

It is shown that in the framework of superconductivity theory, transition temperature T_c is lowered in comparison with that of ure metal when paramagnetic impurities are introduced into a erconductor. The dependence of T_c on the impurity concentra- n is determined. Superconductivity vanishes at a certain critical ıcentration. A detailed study of the thermodynamic and magnetic operties of superconducting alloys in the concentration range se to critical are made. It is found that in that range there is no ponential term in the expression for the heat capacity as $T \to 0$. e concentration dependence of the gap in the energy spectrum of such a system is determined. It is shown that the gap disappears at a concentration $n' \cong 0.9\, n_{cr}$, while at higher concentrations the energy spectrum of the system is continuous. [Engligh translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1243-53 (June, 1961)].

18707 THE TUNNEL EFFECT BETWEEN THIN FILMS OF SUPERCONDUCTING MATERIAL. N.V.Zavaritskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 657-9 (Aug., 1961).
In Russian.

The tunnel effect between thin films of superconducting metal deposited on glass sheets ~ 1 mm thick was investigated at temperatures down to 0.1°K. Metals used were Al, In, Sn, Pb, and the insulation was improved by using a sheet of aluminium oxide or BaF_2. The ratios of tunnel currents in the normal and superconducting states are given, and the variation with temperature of the energy gap in Al is deduced. [English translation in: Soviet Physics—JETP (USA)]. G.E.Murphy

18708 DEPENDENCE OF THE DEPTH OF PENETRATION OF THE MAGNETIC FIELD IN A SUPERCONDUCTOR ON THE MAGNETIC FIELD STRENGTH.
Yu.V.Sharvin and V.F.Gantmakher.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1242-50 (Nov., 1960). In Russian.

The dependence of the depth of penetration δ on the field strength was measured in 10 samples placed in the coil of the resonant circuit of an oscillator operating at 2 Mc/s. The change in frequency accompanying the application of the field was measured accurate to 0.005 c/s, corresponding to a change in δ of about 10^{-9} cm. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 866-72 (May, 1961)].

18709 SECOND SOUND, THE CONVECTIVE MECHANISM OF THERMAL CONDUCTIVITY AND EXCITON EXCITATIONS IN SUPERCONDUCTORS. V.L.Ginzburg.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 828-34 (Sept., 1961). In Russian.

The problem of observing convective thermal conductivity and second sound in superconductors is discussed. The change of the single particle excitation spectrum and especially the existence of exciton excitations in superconductors may, in principle, diminish the role of scattering on impurities. As a consequence, damping of second sound may be significantly smaller and convective thermal conductivity appreciably larger. Some experimental data pertaining to superconducting lead are discussed. A mechanism is indicated which may lead to a Knight frequency shift in superconductors in the case of small samples and large magnetic fields. [English translation in: Soviet Physics—JETP (USA)].

18710 THE UPPER CRITICAL FIELD OF SUPERCONDUCTING ALLOYS. E.A.Shapoval.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3 (9), 877-85 (Sept., 1961).
In Russian.

The magnitude of the upper critical field H_{c_1} in superconducting alloys is derived for the case when the mean free path is small compared with the parameter $\xi_0 = v/\Delta$ in the Bardeen—Cooper—Shrieffer theory (Abstr. 1708 of 1958). The temperature dependence of H_{c_1} is almost linear and the second derivative with respect to temperature is positive. [English translation in: Soviet Physics—JETP (USA)].

18711 THE KNIGHT SHIFT IN THE SUPERCONDUCTING STATE. R.Suzuki and M.Akano.
Nuovo Cimento (Italy), Vol. 21, No. 3, 559-62 (Aug. 1, 1961).

Brief report of a calculation, based on Bogolyubov's method, which leads to a finite Knight shift for superconductors.
R.G.Chambers

18712 SOME NEW SUPERCONDUCTING COMPOUNDS. B.T.Matthias, V.B.Compton and E.Corenzwit.
J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 130-3 (April, 1961).

The transition temperatures and crystal structures of several new superconducting compounds are reported. Some crystal structures are more favourable than others for the occurrence of superconductivity. The transition temperatures reflect the decisive influence of the valence electron concentration.

18713 RESONANT ABSORPTION OF GAMMA RADIATION IN SUPERCONDUCTORS.

P.P.Craig, D.E.Nagle and R.D.Reiswig.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 168-70 (Dec., 1960).

The Mössbauer absorption by Au^{197} in the compounds Au_2Bi and $AuNb_3$ was found not to change detectably when the compounds became superconducting. It is concluded that the nuclear energy shift at the transition is less than 2×10^{-8} eV in Au_2Bi, and less than 4×10^{-7} eV in $AuNb_3$. R.G.Chambers

18714 SUPERCONDUCTIVITY OF CRYSTALLINE MODIFICATIONS OF BISMUTH.

N.B.Brandt and N.I.Ginzburg.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1554-6 (Dec., 1960). In Russian.

The critical temperature T_c for the superconducting modification Bi III was determined, and was found to equal 7.25°K for pressures $25\,000 < p < 29\,000$ atm. Superconductivity of the modification Bi II was discovered with $T_c = 3.93$°K ($p = 25\,000$ atm). The derivarive $\partial T_c/\partial p$ for Bi III is negligibly small; for Bi II $\partial T_c/\partial p \cong$ $\cong -3.5 \times 10^{-5}$ °K atm^{-1}. The stability of the Bi II and Bi III modifications was investigated at liquid helium temperatures. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1082-3 (June, 1961)].

18715 USE OF THIN FILMS FOR THE STUDY OF STRESS EFFECTS ON THE SUPERCONDUCTING TRANSITION OF INDIUM.

A.M.Toxen.
Phys. Rev. (USA), Vol. 124, No. 4, 1018-20 (Nov. 15, 1961).

Measurements on evaporated thin films of superconductors provide a powerful technique for studying stress effects on the superconductivity transition. Utilization of the differential thermal expansion of film and substrate temperature during evaporation provides a convenient way for controlling the stress in the films. In this manner, uniform tensile and compressive stresses of substantial magnitude can be obtained and are tolerable because of the great strength of thin films. To illustrate how this technique can be used, studies are shown of similarity effects in indium films under the influence of biaxial stress and a generalization of the usual similarity relations is suggested.

18716 THE CRITICAL MAGNETIC FIELD OF THIN LEAD FILMS.

E.Shimashek.
Acta phys. Polon. (Poland), Vol. 20, No. 7, 553-61 (1961). In Russian.

The resistivity was measured in an interval of 1.2 deg K below the critical temperature for films between 3.15×10^{-6} and and 1.16×10^{-4} cm thick. For thin films the phase transition from the normal to the superconducting state is reversible in the presence of a magnetic field. For thick films the transition is reversible only near the critical temperature T_K, while the transition is accompanied by hysteresis at temperatures further from T_K. The maximum amount of hysteresis is already obtained for temperatures quite close to T_K. D.J.Thouless

18717 THE SUPERCONDUCTING TRANSITION TEMPERATURE OF LEAD.

J.P.Franck and D.L.Martin.
Canad. J. Phys., Vol. 39, No. 9, 1320-9 (Sept., 1961).

The temperature of the superconducting transition was measured for high-purity lead samples from three different sources. The transition temperature for all samples agreed to within 0.001 deg K and was determined with a gas thermometer to be 7.193°K ± 0.005°K. The transition width for all samples was roughly 0.004 deg K. Some comments on the use of carbon radio resistors as thermometers in the temperature range 3° to 30°K are included.

18718 SUPERCONDUCTIVITY IN THE σ AND α-Mn STRUCTURES.

R.D.Blaugher and J.K.Hulm.
J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 134-8 (April, 1961).

The sigma and alpha-manganese structures formed by binary alloys between the group (V, Nb, Ta, Cr, Mo, W) and the group (Mn, Fe, Co, Ni, Ru, Rh, Pd, Re, Os, Ir, Pt) were investigated for superconductivity down to 1°K. Nineteen new superconductors were found in these two systems with the majority occurring in the sigma phase. A plot of superconducting transition temperature of the sigma phases against the average number of valence electrons per atom exhibited a maximum at approximately 6½ electrons per atom. This maximum is similar to those found for other structures by Matthias [Progress in Low Temperature Physics, Vol. II, Amste North Holland Publishing Company (1957)], but is displace some from the vicinity of 5 or 7 electrons per atom which Matthias indicated to be characteristic of other systems. The sigma phas data therefore suggests that in compound formation between pair of transition elements, the d-band shape is preserved to some extent and is filled at an intermediate level by the available electrons.

18719 SUPERCONDUCTING PROPERTIES OF FRESHLY DEPOSITED MERCURY FILMS.

I.S.Khukhareva.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3 (9), 1728-34 (Sept., 1961). In Russian.

Mercury films obtained by condensation in high vacuum on a backing with a temperature close to that of liquid helium are studied. The experimental results are compared with the Abrik Gorkov theory of superconducting alloys (Abstr. 9659-60 of 1959) [English translation in: Soviet Physics—JETP (USA)].

FIELD EMISSION FROM NIOBIUM IN THE NORMAL AND SUPERCONDUCTING STATES. See Abstr. 18910

18720 INVESTIGATIONS ON SUPERCONDUCTING Nb_3Sn SPECIMENS. I.

F.Lange.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 1, No. 7-10, 408-11 (1959). In German.

Various specimens (wires, strips, films on ceramic substra were made by sintering techniques. The transition temperature has a flat maximum (~ 18°K) and temperature range of the transi has a minimum (~ 0.03°K) for a sintering temperature between 850 and 1100°C, when the sintering time is 20 hours. Excess tin evaporates off at higher temperatures leaving a more or less stoichiometric mixture. All specimens were porous. Critical magnetic fields and critical currents are proportional to $1-(T/T$ within the narrow temperature range investigated (within 0.27° below T_c). In the one case given $H_c = 1.67 \times 10^5[1 - (T/T_c)^2]$ Oe The field produced by the critical current is much lower (1/20 H in one case). See also following abstract. H.Lon

18721 INVESTIGATIONS ON SUPERCONDUCTING Nb_3Sn SPECIMENS. II.

F.Lange.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 3-4, 167-70 (1960). In German.

Hysteresis effects on specimens carrying an electric curren are investigated. They are caused by Joule heating, which is ver pronounced owing to the high resistivity in the normal state (3×10^{-5} ohm cm). H.Lon

18722 SUPERCONDUCTIVITY OF SUPERIMPOSED METAL

A.C.Rose-Innes and B.Serin.
Phys. Rev. Letters (USA), Vol. 7, No. 7, 278-9 (Oct. 1, 1961).

Tin films of thickness 1500-18000 A were evaporated onto a water-cooled gold base, and the transition temperature T_c measu by a magnetic torque method. For thicknesses less than 7000 A, T_c dropped sharply, but the transition departed badly from ideal behaviour. Moreover, after a 7000 A film was re-exposed to the hot, empty evaporating boat, T_c was depressed and non-ideal behaviour appeared. It is concluded that diffusion between film and base metal during evaporation plays a dominant part in the behaviour of such films. R.G.Chamb

18723 THE SUPERCONDUCTIVITY OF TIN AND INDIUM UNDER PRESSURE.

L.S.Kan, B.G.Lazarev and V.I.Makarov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 457-9 (Feb., 1961). In Russian.

The shift in the critical temperature due to pressure was measured over the pressure range 0-1730 kg/cm^2. A linear dependence $T_c(p)$ is observed for indium over the entire pressur range, while tin shows an appreciable deviation from linearity at pressures of 400-800 atm. The linearity of the function $T_c(p)$ for indium, which has a simple Fermi surface, is compared with the complicated variation of $T_c(p)$ in thallium and tin, which have complicated Fermi surfaces. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 317-19 (Aug., 1961)].

QUENCHED-IN DEFECTS IN TIN AND THE SUPERCONDUC ING TRANSITION TEMPERATURE. See Abstr. 17507

8724 MEASUREMENT OF THE ANISOTROPY OF THERMAL CONDUCTIVITY OF ZINC AND CADMIUM IN THE ERCONDUCTING STATE. N.V.Zavaritskii.
eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1193-7 (Nov.,)). In Russian.

Measurements were made along different crystallographic ctions. The anisotropy in the temperature dependence of the tronic thermal conductivity is ascribed to an anisotropy in the h of the gap in the energy spectrum of the excitations in these als. [English translation in: Soviet Physics—JETP (USA), 12, No. 5, 831-3 (May, 1961)].

ELECTRICITY

ELECTRICAL MEASUREMENTS AND CIRCUITS

18725 A BOUND OF THE DERIVATIVE OF IMPEDANCE FUNCTIONS. F.M.Reza.
. Acad. Sci. (France), Vol. 253, No. 8, 1034-5 (Aug. 21, 1961). rench.

An upper bound is obtained for the derivative with respect to quency of the complex impedance of a linear circuit.

W.E.Williams

8726 ON THE METHOD OF MEASURING HALL CO-EFFICIENT AT MICROWAVE FREQUENCIES.
amagata.
Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 3, 235-46 ne, 1960).

A theory of the method of measuring the Hall coefficient at rowave frequencies by using a bimodal or dual-mode cavity was eloped. The principal feature of the theory is that it is a straight lication of the method developed by Slater in treating microwave onant cavities. The treatment is similar to that performed by tis and Teaney (Abstr. 4858 of 1959), but an essential difference nat the cavity without initial unbalance was treated. The theory pplicable to the cavity used by Nishina and Spry, and detailed culations show that the equation used by them for obtaining the ility from their experimental data is valid under very restricted eria. The equations which can be applied for much more general erimental arrangements are derived. The theory can also be d to calculate the initial resistive unbalance.

8727 H.F.POWER METER FOR OPERATION AT 2.5 MW PULSED POWER. E.Zaccheroni.
lear Instrum. and Methods (Internat.), Vol.8, No. 3, 304-12 t., 1960).

A description is given of an oil-cooled dummy load specially structed to measure the output power of the 2.5 MW pulse lifier of the Cern linear accelerator. The equipment can be both as a dummy load and as a calorimetric power meter. angements have been made to use it also as an attenuator of more 30 dB.

18728 SYNCHROTRON MAGNET POWER CIRCUIT WITH A DISTRIBUTED CAPACITOR BANK. S.Waaben.
lear Instrum. and Methods (Internat.), Vol. 9, No. 1, 78-86 ., 1960).

Deals with a ring circuit suitable for exciting the bending gnets with exactly equal d.c. biased sinusoidal currents. A dis-uted series resonance excitation is made practicable by the intro-tion of network constraints on the capacitor potentials. The tral network component is a transformer choke. The practicable angements of the choke topology may take various forms deter-ed essentially by economic considerations. Model tests and lysis are given.

18729 CONTRIBUTION TO THE DESIGN OF WIDE BAND TUNED OR UNTUNED AMPLIFIERS USING ANSISTORS UP TO 250 Mc/s. J.M.Colin.
. Phys. (France), Vol. 6, No. 7-8 (July-Aug., 1961). In French.

18730 A DOUBLE-DELAY-LINE LINEAR AMPLIFIER EMPLOYING TRANSISTORS. I.
F.S.Goulding, R.W.Nicholson and J.B.Waugh.
Nuclear Instrum. and Methods (Internat.), Vol. 8, No. 3, 272-81 (Sept., 1960).

A transistor amplifier designed mainly for precise scintillation counter spectroscopy is described. Techniques such as double-delay-line pulse shaping and considerable negative feedback result in excellent linearity, gain stability and overload behaviour at high counting rates. An input charge of 2×10^{-13} Coulombs develops a ±4V output pulse into a 100 Ω matched cable which feeds the Chalk River kicksorter. With 1 μsec pulse shaping lines the input equivalent r.m.s. noise is 4000 ion-pairs. Lower noise may be achieved by using shorter lines. The amplifier rise-time is 0.2 μsec (10 to 90%). Use of plug-in printed circuit boards increases the versatility of the amplifier and simplifies the adjustment procedures.

18731 A TRANSISTORIZED FAST-SLOW COINCIDENCE AND PULSE AMPLITUDE SELECTING SYSTEM. II.
F.S.Goulding and R.A.McNaught.
Nuclear Instrum. and Methods (Internat.), Vol. 8, No. 3, 282-96 (Sept., 1960).

Describes a system developed for fast—slow coincidence experiments in nuclear physics and discusses the design of functional units including a low level discriminator, single or dual-channel analyser, coincidence circuit and linear gate. The system is designed to use the ±4V double-delay-line shaped pulses produced by the amplifier described in the preceding paper or equivalent pulses from other amplifiers. Operation with single phase pulses of similar amplitude is also possible but with reduced performance. Uncertainty of the discriminator threshold and the spurious pedestal and disturbances introduced by the linear gate are less than 10 mV under all normal operating conditions. Functional units of the system are constructed on printed circuit boards which plug into a base unit where interconnections are made between them through a programming plug. This arrangement allows the experimenter to change interconnections quickly and makes the whole system extremely versatile. The system also takes advantage of the timing accuracy of the zero cross-over of double-delay-line pulses to give a coincidence resolving time of 40 nsec while using no fast amplifiers or coincidence circuits. A technique of compensating for baseline shift at high counting rates of single phase pulses is also described.

18732 EFFECTS OF SATURATION AND DEAD TIME IN THE AMPLITUDE ANALYSERS. P.Moatti.
J. Phys. Radium (France), Vol. 22, No. 3, 192 (March, 1961). In French.

A theoretical expression for the number of counts recorded in each channel is given as a function of the dead time and counting rates. A method for the measurement of the dead time is also suggested.

J.B.Garg

18733 TRANSISTOR COUNTING-RATE CHANNEL FOR TRIGA REACTORS. J.H.Cawley.
Nucleonics (USA), Vol. 19, No. 9, 82-6 (Sept., 1961).

Full details and circuit diagrams are given for a transistorized counting channel, comprising preamplifier, main amplifier, discriminator, log rate meter, a calibration oscillator and an audible count-rate indicator.

R.D.Smith

18734 A UNIVERSAL METHOD FOR STABILIZING SCINTILLATION SPECTROMETER SYSTEMS.
S.Haun and D.Kamke.
Nuclear Instrum. and Methods (Internat.), Vol. 8, No. 3, 331-8 (Sept., 1960). In German.

The gain of a scintillation-spectrometer can be held constant for long measuring times by including the spectrometer in a regulation circuit. All devices of this kind which have been described as yet are dependent on specific features of the spectrum and many situations arise where none of them can be used. The introduction of a pulsed source of light makes such stabilization devices universally applicable. This paper describes a light source and a suitable stabilization circuit with which a stability better than 0.5% was achieved for a 14 hour period, starting immediately after turning on the electronic circuits. The static and dynamic regulation properties are given as well as a method for evaluating all the effects due to the statistical character of the pulse height distribution produced by the light source and the photomultiplier.

18735 PULSE HEIGHT DISCRIMINATOR EMPLOYING DISTRIBUTED AMPLIFICATION. C.Infante.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 102-6 (Oct., 1960).

The discriminator accepts 0.5-12 V positive input pulses with a maximum repetition rate in excess of 20 Mc/s. Dead time is less than 25 mμsec and threshold uncertainty is 30 mV. The circuit uses 20 vacuum-tubes in an arrangement believed to be new.

18736 HIGHER ORDER CHANCE COINCIDENCES IN A FAST—SLOW COINCIDENCE ARRANGEMENT.
H.Paul.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 131-6 (Nov., 1960).

An ordinary fast—slow coincidence measurement with two radiation detectors is considered. In addition to the chance coincidences due to two pulses (one from each detector) there are higher order chance coincidences which require a total of three or four pulses and whose relative contributions to the counting rate increase with source strength. Formulae for these effects are given, and methods for measuring the corrections are discussed. For a source with a simple decay scheme, and for the special cases of either very narrow or very wide analyser channels it is shown that the higher order corrections may be neglected if the single counting rates are small compared to the reciprocal resolving time of the slow coincidence circuit.

18737 AUTOMATIC LIVE-TIME MEASUREMENT AND BACKGROUND SUBTRACTION FOR THE HUTCHINSON—SCARROTT PULSE HEIGHT ANALYSER. K.F.Orton and K.Wilkins.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 97-101 (Oct., 1960).

A circuit is described which measures the live-time of the pulse height analyser, presents this value on a Dekatron display and automatically performs background subtraction for preset periods of live-time.

18738 TIME MEASUREMENT IN THE NANOSECOND REGION: A TIME-TO-PULSE HEIGHT CONVERTOR AND COINCIDENCE CIRCUITS. R.Ballini and E.Pomelas.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 29-36 (Oct., 1960). In French.

A time-to-pulse height convertor, associated with a pulsed accelerator was improved by using an electron beam switching tube and a convenient shaping of photomultiplier pulses. Such pulses were applied to a transistorized millimicrosecond coincidence circuit.

18739 NOTES ON A FAST TIME ANALYSER FOR SHORT LIFETIME MEASUREMENTS.
M.Bonitz and E.J.Berlovich.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 13-20 (Oct., 1960).

A critical comparison of the single- and multichannel method for short lifetime measurements of excited states in nuclei is given. A new time-to-height converting system based on the pulse overlap principle of a biased diode discriminator, was constructed. The time resolution of the prompt $\gamma-\gamma$ coincidence curve from a Co^{60} source is 5×10^{-10} sec. The influence of the energy of the coinciding particles on the performance of the time analyser, and a stability control method are discussed. Experimental results are given for the following excited levels: 145 keV in Pr^{141}, $T_{1/2} = (2.0 \pm 0.2) \times$ $\times 10^{-9}$ sec; 279 keV in Tl^{203}, $T_{1/2} = (2.9 \pm 0.2) \times 10^{-10}$ sec and 411 keV in Hg^{198}, $T_{1/2} = (3.5 \pm 0.8) \times 10^{-11}$ sec.

18740 THE MEASUREMENT OF SHORT TIME INTERVALS. J.Duclos, R.Van Zurk, S.André and J.Fleury.
J. Phys. Radium (France), Vol. 21, No. 5, 385-7 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Genoble, 1960 (see Abstr. 12029 of 1961). Two fast coincidence circuits were studied for use in fast neutron time-of-flight spectrometry and short half-life measurements ($10^{-9}-10^{-10}$ sec): a chronotron able to analyse automatically with a multichannel amplitude selector (2.10^{-10} sec per channel), and a very fast coincidence (5×10^{-10} sec) differential circuit with a movable channel. A time-to-height converter derived from the Bell circuit is also studied. A short description of these circuits and the performances obtained are given.

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

18741 DERIVATION OF AN EQUATION FOR THE POTENT IN THE NEIGHBOURHOOD OF THE EDGE OF A THI CONDUCTOR HAVING ROTATIONAL SYMMETRY. É.Durand.
C.R. Acad. Sci. (France), Vol. 253, No. 7, 986-8 (Aug. 16, 1961). In French.

An equation is derived which enables the electrostatic potent to be determined at a number of points in the neighbourhood of th ends of a hollow charged cylinder. R.A.Bor

18742 DERIVATION OF AN EQUATION FOR THE POTENT IN THE NEIGHBOURHOOD OF THE EDGE OF A SOL CONDUCTOR HAVING ROTATIONAL SYMMETRY. É.Durand.
C.R. Acad. Sci. (France), Vol. 253, No. 8, 1036-8 (Aug. 21, 1961) In French.

An equation is derived which enables the electrostatic potent to be calculated at a number of points in the neighbourhood of the ends of a solid charged cylinder. R.A.Bo

18743 UNCHARGED CONDUCTING TOROIDAL RING IN A UNIFORM ELECTRIC FIELD. S.C.Loh.
Canad. J. Phys., Vol. 39, No. 10, 1495-1500 (Oct., 1961).

Mathematical expressions for the potential function of an uncharged conducting toroidal ring placed in a uniform electric field are derived and expressed in terms of toroidal functions. So numerical results were calculated by the IBM 650 computer at th University of Toronto and are included in the present paper. To verify the calculated results, a systematic study of an electrolyti tank was undertaken. It was found that the theoretical calculatio agreed well with the experimental results.

18744 THE DIELECTRIC CONSTANT AND MAXWELL—WAGNER DISPERSION OF SUSPENSIONS OF ORIENTED PROLATE SPHEROIDS. M.Mandel.
Physica (Netherlands), Vol. 27, No. 9, 827-40 (Sept., 1961).

New formulae are proposed for the static dielectric constant moderately concentrated suspensions of oriented prolate spheroi They were derived from the more general theory of Polder and Santen (Abstr. 110 of 1947). For spheroids more polarizable tha the suspending medium the formulae are valid for a ratio of the axis larger than 5. In the opposite case, no formal difference appears between moderately concentrated suspensions and very dilute ones. A discussion is also given for the Maxwell—Wagner dispersion for such suspensions.

18745 ELECTRIC FORCES IN A TRANSPARENT DISPERSIVE MEDIUM. L.P.Pitaevskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1450-8 (Nov., 1960). In Russian.

It is shown that the expression for the stress tensor of a variable electric field in a transparent dispersive medium is the same as the usual expression for a nondispersive medium. It is also shown that if the parameters of the medium are time-depen an imaginary part appears in the dielectric susceptibility, which a real quantity for time-independent parameters. An expression derived for the stress tensor of a variable electric field in a transparent liquid located in a constant magnetic field. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 1008-13 (May, 1961)].

CURRENT ELECTRICITY
ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

8746 ON THE VALIDITY OF EXTREMAL PRINCIPLES OF ENTROPY PRODUCTION FOR STATIONARY
CTRICAL FLOWS. F.Krause and M.Steenbeck.
r. Plasma Physik (Germany), Vol. 1, No. 2, 65-81 (1960-61).
erman.

By restricting the variations to physically realizable states it
iown that the stationary flow of electric current can be
ribed by a principle of minimum entropy production if and only
e electrical conductivity is independent of the electric field.
mple counter-example involving a non-ohmic resistance is
ribed and discussed. R.O.Davies

18747 THE DISTRIBUTION OF CURRENT DENSITY IN A CYLINDRICAL CONDUCTOR OF ELLIPTIC
SS-SECTION FOR AXIAL DIRECTION OF ALTERNATING
RENT. J.Bauer and J.Schneider.
. phys. Austriaca, Vol. 14, No. 2, 218-31 (1961). In German.

Calculation of the skin effect in an infinite cylindrical
luctor of elliptic cross-section. The differential equation for
ield components is obtained by transforming the Maxwell
tions into elliptic cylindrical coordinates. Solutions for both
and for high frequencies are discussed. These solutions
ce to known equations when the elliptic cross-section becomes,
e limit, circular. Formulae for the resistance and induct-
of such a conductor are given. J.K.Skwirzynski

18748 ON AN ARRANGEMENT FOR THE DIRECT CONVERSION OF HEAT ENERGY INTO ELECTRICAL
RGY. W.Bloss.
rwissenschaften (Germany), Vol. 48, No. 14, 497 (1961).
erman.

Describes a plasma diode which has a BaO heated cathode and a
iconducting layer on the anode. The positive ions for space-
ge compensation are provided by an argon or krypton discharge
een the main cathode and a small auxiliary heated cathode. The
ut current depends on the current and burning voltage of this
liary discharge. Efficiencies of 8.6% have been obtained and
sionally up to 20%. The advantages claimed are the low working
erature of the cathode and the possibility of obtaining an alter-
g output by switching the auxiliary discharge. J.W.Sturgess

18749 ION SIZE EFFECT AND MECHANISM OF ELECTROLYTIC RECTIFICATION.
Schmidt, F.Huber and R.F.Schwarz.
hys. Chem. Solids (GB), Vol. 15, No. 3-4, 270-90 (Oct., 1960).

A review is given of previous theories of electrolytic rectifica-
and it is shown that none of them are able to account for all the
omena observed. Experimental results are then presented
h show that both the magnitude of the cathodic current at a
n applied field, and the activation energies for cathodic current
are controlled by the size of the cation in solution, and by
ific adsorption under applied cathodic bias. The existence of
rface barrier, height about 1 V, thickness about 250 A, has been
ed. The proposed band scheme for anodic oxide layers thus
des a steep surface barrier at the outer oxide interface, an
ic contact at the valve metal/oxide interface, and traps in the
e.

18750 SUMMARIZED PROCEEDINGS OF A CONFERENCE ON THERMOELECTRICITY — DURHAM, JULY 1961.
.Pamplin.
. J. appl. Phys., Vol. 12, No. 11, 592-4 (Nov., 1961).

This report gives a summary of the main features of the
ers presented at a conference held by the Institute of Physics
the Physical Society in the University of Durham on 10th, 11th
12th July 1961.

8751 SOME PROBLEMS IN THE DEVELOPMENT OF A COMMERCIAL THERMOELECTRIC REFRIGERATOR.
.Burnett, H.O.Lorch and J.E.Thompson.
t. J. appl. Phys., Vol. 12, No. 11, 595-602 (Nov., 1961).

Two basic problems in the development of a thermoelectric refrigerator are the construction of a cooling unit, consisting of the thermoelectric junctions, and the complete refrigerator design which makes best use of the thermoelectric material. It is essential for the unit to achieve good thermal contact with the cooling chamber and to have good electrical contact across the p and n semiconductor bars forming each junction. A simple but accurate method for measuring the junction resistance is shown, and the relative merits of various methods of forming the cooling unit are discussed. The heat balance equations for a refrigerator are given which include the cooling fin system, and the method of optimization of the design is noted.

18752 MEASUREMENT OF THE FIGURE OF MERIT OF A THERMOELECTRIC MATERIAL.
A.E.Bowley, L.E.J.Cowles, G.J.Williams and H.J.Goldsmid.
J. sci. Instrum. (GB), Vol. 38, No. 11, 433-5 (Nov., 1961).

A description is given of a single piece of apparatus for measuring the three parameters involved in the figure of merit of a thermoelectric material. This apparatus uses only direct current and is based on Harman's technique (Abstr. 1492 of 1959), in which a temperature gradient is established by means of the Peltier effect. It is demonstrated that the corrections for radiative heat transfer take a relatively simple form at room temperature. It is also shown that the figure of merit of a thermoelectric material can be obtained by measuring the maximum lowering of temperature using the Peltier effect in a junction between the sample under test and a metal.

18753 THE EFFECT OF PRESSURE ON THE ELECTROMOTIVE FORCE OF A PLATINUM—BISMUTH THERMOCOUPLE. G.C.Kennedy and R.C.Newton.
J. geophys. Res. (USA), Vol. 66, No. 5, 1491-4 (May, 1961).

The e.m.f. of a Pt—Bi thermocouple changes discontinuously as the Bi undergoes various polymorphic transitions at high pressures. The e.m.f. of a Pt—Bi I thermocouple is approximately +10 mmV deg^{-1} C at 30°C. The e.m.f. of a Pt—Bi II thermocouple is approximately −30 mmV deg^{-1} C. The e.m.f. of a Pt—Bi III thermocouple is approximately −10 mmV deg^{-1} C. The phase change of Bi I → Bi II takes place at 25.4 kb at 20°C, and the change from Bi II → Bi III takes place at 27 kb at 20°C. Thus under certain circumstances appropriate thermocouples in high-pressure envireonments can be used to measure pressure.

THE INFLUENCE OF THERMOELECTRIC EFFECTS ON THE MAXIMUM TEMPERATURE IN A RADIALLY CONSTRICTED GAS DISCHARGE BETWEEN ELECTRODES. See Abstr. 18781

IONIZATION

18754 ELECTRONEGATIVITY.
R.P.Iczkowski and J.L.Margrave.
J. Amer. Chem. Soc., Vol. 83, No. 17, 3547-51 (Sept. 5, 1961).

The energies of positive and negative ions relative to the neutral atoms are conveniently and accurately expressed for a given atom by a power series in $N = n - Z$, where n = the number of electrons around the nucleus in a given ionization state and Z = the atomic number of the nucleus. For a neutral atom the electronegativity is defined as $\chi = (-dE/dN)_{N=0}$, where dE is the energy change which accompanies the change in charge dN, and should be expressed in the units energy per electron. Similarly $(-dE/dN)_{N=-1}$ represents the electronegativity of the singly charged positive ion. The $E(N)$ curve exhibits a discontinuity in slope at N values, where there is a transition from one type of atomic orbital to another. If only the first ionization potential and the first electron affinity are known for a given species, $\chi = (-dE/dN)_{N=0}$ is equivalent to the well-known Mulliken relationship that electronegativity is equal to the average of the ionization potential and the electron affinity.

18755 CALCULATION OF THE RATE OF IONIZATION IN A FEEBLY IONIZED GAS IN THE PRESENCE OF AN ELECTRIC FIELD. J.Papet-Lépine.
Ark. Fys. (Sweden), Vol. 19, Paper 4, 33-46 (1961). In French.

On the basis of the consideration of the probabilities of the various collision processes leading to changes in the state of molecules, theoretical expressions are derived for the rate of ionization for the three cases $T_e - T_g \leq T_g$, $T_e - T_g < T_g$ and $T_e - T_g > T_g$ (T_e is electron temperature, and T_g gas temperature). Numerical computations are given for nitrogen.

J.Dutton

18756 THE POSSIBILITY OF DECREASE IN THE VALUE OF IONIZATION FLUCTUATIONS IN GASES.

A.A.Vorob'ev, A.P.Komar and V.A.Korolev.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 1, 54-7 (March 1, 1961).
In Russian.

The question of possible decrease in the magnitude of fluctuations in ionization of gases in investigated. The author believes that the fluctuations are determined by the distribution of the number of both ionized and excited atoms. An analytical expression for the coefficient of fluctuations in ionization in gases is obtained by including the probability of supplementary ionization as caused by the collisions of metastable atoms with the molecules. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 3, 219-21 (Sept., 1961)].

S.P.Talwar

18757 ELECTRICAL BREAKDOWN OF GASES: IONIZATION GROWTH IN AIR AT HIGH PRESSURES.

J.Dutton, F.Llewellyn Jones and R.W.Palmer.
Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 569-83 (Oct., 1961).

The experimental conditions which have to be satisfied in order to measure ionization coefficients accurately at high values of the parameter pd (pressure × gap distance) are assessed. In an apparatus designed to fulfil these conditions, precision measurements were carried out for uniform electric fields E in air at values of the parameter pd up to 2300 mm Hg cm, which corresponds to a sparking potential of about 80 kV, thus extending the range so far investigated by Llewellyn Jones and Parker (Abstr. 6516 of 1950; 5806 of 1952). The results show that pre-breakdown ionization growth in air is due to the action of primary (α) and secondary (ω) ionization processes modified by the process of attachment a, and that significant space charge effects were absent. At a value of pd of 2300 mm Hg cm the sparking potential calculated (81 ± 1.5 kV) from the criterion (expressed in terms of the ionization and attachment coefficients) which gives the static sparking potential was in agreement, within the experimental error, with that (79 ± 0.7 kV) observed. It was also shown that the state of the cathode surface had a marked influence on the secondary ionization even at these higher values of pd. For $35 \leq E/p \leq 40\ \mathrm{V\ cm^{-1}}$ $(\mathrm{mm\ Hg})^{-1}$ and pressures between 400 and 1000 mm Hg, the apparent secondary ionization coefficient $\omega/(\alpha - a)$ was found to be a function of E/p alone, whereas the apparent primary ionization coefficient $(\alpha - a)/p$ showed a small, just detectable decrease with increasing pressure at a given value of E/p.

18758 ATOMIC FIRST IONIZATION POTENTIALS DETERMINED BY THE METHOD OF SURFACE IONIZATION.

N.I.Ionov and M.A.Mittsev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 741-2 (March, 1961).
In Russian.

Atoms of Er, Tb and Ce, together with the molecule $ThCl_4$, were studied using the method of surface ionization on polycrystalline tungsten. It is shown that the temperature dependence of the ion current agrees with the theory of surface ionization on complex surfaces. The ionization potentials of the atoms Er, Tb, Ce and Th were found by comparing the temperature dependence of their respective ion currents with the same quantity for positive In ions. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 518-19 (Sept., 1961)].

18759 REPRESENTATION BY FORMULA OF THE IONIZATION CROSS-SECTION FOR ELECTRON IMPACT.

H.W.Drawin.
Z. Phys. (Germany), Vol. 164, No. 5, 513-21 (1961). In German.

An empirical analytical expression for the ionization cross-sections is given which is in very good agreement with experimentally measured cross-sections, and which is able to give a large part of the ionization curves as a function of the energy of the impacting electrons. For high electron energies the formula is in agreement with the quantum mechanical expression for the ionization cross-section (Born—Bethe formula).

18760 ABSOLUTE MEASUREMENT OF W FOR Po^{210} ALPHA PARTICLES IN AIR, NITROGEN AND CARBON DIOXIDE. Z.Bay, P.A.Newman and H.H.Seliger.

Radiation Research (USA), Vol. 14, No. 5, 551-65 (May, 1961).

W is the average energy expended in producing an ion pair. The method used was to measure the integrated charge produced in ionization chamber and to simultaneously measure the number o alpha-particles. The alpha-particle energy was taken to be 5.3054 ± 0.001 MeV. The results in eV/ion pair are:

air: $W = 34.97 \pm 0.07$
nitrogen: $W = 36.38 \pm 0.07$
carbon dioxide: $W = 34.04 \pm 0.1$

J.L.Red

18761 IONIZATION EFFICIENCY CURVES FOR A^+, Kr^+, N AND CO^+ BY ELECTRON IMPACT. Y.Kaneko.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1587-93 (Aug., 1961).

The shape of ionization efficiency curves (I.E. curves) obtai by essentially monoenergetic electron impact is studied by mean of the threshold law. In the I.E. curves for N_2^+ and CO^+, some humps which are attributed to autoionization processes are found These processes occur at 16.2 ± 0.1 eV for N_2^+ and at 15.6 ± 0.1 and 18.4 ± 0.1 eV for CO^+. Though the shape of I.E. curve for K obtained in this work is similar to that of Fox et al (Abstr. 1946 1955) and Frost et al (Abstr. 9732 of 1955), it is difficult to inter this shape by autoionization process only. The I.E. curve for A^+ shows a large tailing of 0.50 ±0.05 eV which can not be explained the doublet state of A^+. The ionization potentials determined for rare gases and some diatomic molecules agree well with spectroscopic values and the previous electron impact data.

18762 MEASUREMENT OF THE FLUCTUATIONS OF IONIZATION OF α-PARTICLES IN ARGON.

A.P.Komar, A.A.Vorob'ev and V.A.Korolev.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 4, 795-7 (Feb. 1, 1961).
In Russian.

An ionization chamber provided with a grid was used to measure the mean square value of the fluctuations in the number ion pairs generated by α-particles of a given energy in argon. T results are in good agreement with the theoretical values predict by Fano (Abstr. 2593 of 1947). [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 2, 131-3 (Aug., 1961)].

G.Mart

18763 ELECTRON ENERGY DISTRIBUTION DURING THE PHOTOIONIZATION OF AROMATIC AMINES IN THE GASEOUS PHASE.

F.I.Vilesov, B.L.Kurbatov and A.N.Terenin.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 6, 1329-32 (June 21, 1961).
In Russian.

For abstract, see Abstr. 16263 of 1961. [English translatio in: Soviet Physics—Doklady (USA), Vol. 6, No. 6, 490-3 (Dec., 19

18764 PRODUCTION OF HIGH ION DENSITIES IN HELIUM MEANS OF HIGH EXPLOSIVES.

G.E.Seay, L.B.Seely, Jr and R.G.Fowler.
J. appl. Phys. (USA), Vol. 32, No. 11, 2439-47 (Nov., 1961).

Temperatures of about 20 000°K with ion densities ranging f 10^{17} to $10^{18}\ \mathrm{cm^{-3}}$ were produced in helium by means of explosive-driven shocks. Helium was used because of its relatively simple structure, but this choice eliminated usual shock methods becaus of the high speed of sound and high ionization potential. Shock w of sufficient strength and planarity were obtained by reflecting against a glass plate initially strong shock waves produced by hi explosives. Equilibrium calculations based on smear camera ve cities of accurately plane shocks were used to determine the sta the gas behind the reflected shock wave. The light emitted consi of a continuum on which were superimposed shifted and broadene lines of the normal helium spectrum, and forbidden lines as well Time-resolved spectrograms showed evidence of a measurable r laxation time at the shock front but no evidence of significant ra tive cooling of the gas behind the shock. Under the conditions of these experiments, it was demonstrated that a quantitative predi of the behaviour of the helium states with principal quantum num 2, 3, and 4 requires consideration of the effects of electrons as as ions.

18765 A MEASUREMENT OF THE IONIZATION CROSS-SECTION OF HELIUM IONS BY ELECTRON IMPAC

K.T.Dolder, M.F.A.Harrison and P.C.Thonemann.
Proc. Roy. Soc. A (GB), Vol. 264, No. 1318, 367-78 (1961).

An apparatus, based on the crossed-beam principle, is desc for measuring the ionization cross-section of ions by electron in

The cross-section for the reaction $He^+ + e^- \rightarrow He^{2+} + 2e$ is rmined from the threshold at 54.4 to 1000 eV. The results are pared with the ionization cross-section of atomic hydrogen and theory. The He^+ cross-section, when scaled by the appropriate or, is very similar to that of atomic hydrogen but increases e rapidly in the neighbourhood of the threshold. At the highest tron energies the cross-section agrees well with that predicted he Coulomb—Born approximation but is considerably lower at cross-section maximum. For electron energies above 150 eV error in the measurement is estimated to be less than ±10%.

8766 STUDY OF THE REACTIONS PRODUCED BY A BEAM OF MOLECULAR HYDROGEN IONS TRAVERSING A TRAL GAS. J.Guidini.

Acad. Sci. (France), Vol. 253, No. 5, 829-31 (July 31, 1961). rench.

Presents results of dissociation and charge exchange cross-ion measurements obtained in the ion energy range from 30 to keV. C.G.Morgan

8767 IONIZATION CROSS-SECTION OF O V DUE TO ELECTRON IMPACT BY CONSIDERATION OF RTIAL EXCHANGE. F.B.Malik and E.Trefftz.

Naturforsch. (Germany), Vol. 16a, No. 6, 583-98 (June, 1961). erman.

The ionization cross-section of highly ionized oxygen, O^{4+}, is ulated according to "distorted-wave" method. Exchange between scattered and the ejected electron is taken into account as far t is of long range nature. It is shown that contributions of high l angular momentum L are essential, L = 0 giving only 3% of total cross-section. This result should qualitatively be the e for all highly ionized atoms, whereas the following seems to special feature of O V ionization: for energies around twice ionization energy the contributions of the optically allowed sitions of the ejected electron (angular momentum $l_{ej} = 1$) are tively small. The contributions of l_{ej} = 0, 1, 2 and 3 are about , 18%, 24% and 19% respectively for $E = 20 \times 13.6$ eV = 2.39 nization energy. The maximum cross-section is 0.112 at. 0.31×10^{-18} cm^2 for electrons of 310 eV kinetic energy × ionization energy). It is about twice as large as given by the ert formula (Abstr. 7893 of 1952).

18768 RATE AND MECHANISM OF THE THERMAL IONIZATION OF XENON. H.S.Johnston and W.Kornegay.

ns Faraday Soc. (GB), Vol. 57, Pt 9, 1563-77 (Sept., 1961).

The rate of the chemical reaction $Xe \rightarrow Xe^+ + e^-$ between 0-7600° K was followed by microwave absorption in a shock tube. ults are explained in terms of the mechanism:

$$M + Xe \underset{b}{\overset{a}{\rightleftharpoons}} M + Xe* \overset{c}{\rightarrow} M + Xe^+ + e^-.$$

complex rates are resolved into two empirical rate constants, nd k_2. From the observed activation energies it is concluded that c, and in this case the empirical k_1 is a and the empirical k_2 is The activation energies are: $E_1 = 8.4 \pm 1$ eV, and $E_2 = 3.7 \pm 1$ eV ionization potential of xenon is 12.1 eV), and the cross-section the second process is about 10^3 times that for the first. By ue of imprisonment of resonance radiation, the quantum of rgy represented by Xe* is held in the system for a large number ollisions.

18769 QUANTAL STUDY OF DIFFUSION AND VISCOSITY CROSS SECTIONS FOR A SCREENED COULOMB TENTIAL. M.R.C.McDowell and G.Peach.

s. of Fluids (USA), Vol. 4, No. 11, 1332-41 (Nov., 1961).

Born's approximation and the Massey—Mohr approximation are d to obtain quantum-mechanical values of the diffusion and vis-ity cross-sections Q_D and Q_η for a screened Coulomb potential. parameters are chosen to represent an ionized gas with $\leq n_e \leq 10^{18}$, n_e being the electron density, and $5 \times 10^3 \leq T_e \leq 10^7$ °K, being the temperature. The scattering phase-shifts are also luated and compared with those obtained from direct numerical gration of the scattering equation. Born's approximation to the se-shift is used in a Faxén-Holtsmark type analysis to give more urate values of the cross-sections at low T_e and large n_e. The ults are used to discuss the behaviour of the electrical conduct-y of a fully ionized gas.

18770 ELECTRON DISTRIBUTION FUNCTION OF A WEAKLY IONIZED GAS IN MAGNETIC AND TIME-DEPENDENT ELECTRIC FIELDS. J.S.Zmuidzinas and C.S.Wu.

Ann. Phys. (USA), Vol. 15, No. 3, 387-402 (Sept., 1961).

An investigation is made of the electron behaviour in a weakly ionized gas in a magnetic field and arbitrarily time-dependent electric field. This problem is of interest either in astrophysics or the study of the basic phenomena in gas discharge. The electron distribution function is studied based on the Boltzmann equation which takes only the electron—atom collisions into account. A "moment method" is devised to solve the case when the electron collision frequency is uniform. In the subsequent analysis, the electron distribution function is first expanded in terms of both the "moments" and the associate Laguerre polynomials and then a generating equation of the moments is derived. This generating equation which is linear and of first order in time can be integrated readily. The persistent solution is obtained in closed form for the quasi-steady case. In case of high-frequency oscillating electric field the drift velocity, the mean energy, the conductivity and the dielectric constant are all discussed.

18771 CONSIDERATION OF THE DETACHMENT OF ELECTRONS FROM NEGATIVE IONS BY THE MEASUREMENT OF IONIZATION AND ATTACHMENT COEFFICIENTS α AND η. H.Schlumbohm.

Z. Naturforsch.(Germany), Vol. 16a, No. 5, 510-12 (May, 1961). In German.

The influence of the detachment of electrons from negative ions on the simultaneous stationary measurements of the coefficients of ionization α and attachment η is discussed by calculating log . versus d curves. Comparison of values of $(\alpha - \eta)$ obtained by the pulse-method with stationary measurements shows the expected tendency as caused by the detachment process.

18772 NEGATIVE ABSORPTION COEFFICIENTS IN DISCHARGES IN GAS MIXTURES. V.A.Fabrikant.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 524-7 (Aug., 1961). In Russian.

Conditions yielding negative absorption coefficients due to selective excitation of atoms to the upper level and to selective removal of atoms from the lower lever are considered for an electric discharge in a mixture of two gases, the actual relations between the probabilities of the various processes being taken into account.

18773 DRIFT VELOCITIES OF ELECTRONS IN ARGON, NITROGEN AND ARGON MIXTURES.

T.Nagy, L.Nagy and S.Dési.

Nuclear Instrum. and Methods (Internat.), Vol. 8, No. 3, 327-30 (Sept., 1960).

Drift velocities of electrons produced by fission fragments in a parallel-plate ionization chamber were measured in argon, nitrogen, and mixtures of gases, such as argon-nitrogen, argon-carbon dioxide and argon-methane. The results obtained are compared with data reported in the literature.

SOME PROBLEMS IN RELATIVISTIC GAS DYNAMICS OF CHARGED PARTICLES. See Abstr. 18469

18774 RECOMBINATION THROUGH ELECTRON—ELECTRON COLLISIONS. D.R.Bates and A.E.Kingston.

Nature (GB), Vol. 189, 652-3 (Feb. 25, 1961).

Preliminary results are given of a calculation on the dependence of the recombination coefficient of this reaction on the electron density, in a hydrogen plasma at 16000° K, which is almost completely ionized and which is optically thin so that the absorption of the emitted photons may be neglected. G.Martelli

18775 DEIONIZATION RATE OF RAREFIED HELIUM IN A MAGNETIC FIELD. II.

A.S.Sÿrgii and V.L.Granovskii.

Radiotekhnika i Elektronika (USSR), Vol. 5, No. 9, 1522-30 (Sept., 1960). In Russian.

For Pt I see Abstr. 11912 of 1961. An investigation was made to clarify the influence of a magnetic field on the relative importance of space recombination and diffusion in the deionization process of a gas for values of field up to 1500 Oe. It was found that the loss of ions by space recombination increases with increase of field and decrease of pressure and predominates for gas pressures in the region of 10^{-2} to 10^{-1} mm Hg and for carrier concentrations greater than 10^{11} cm^{-3} in the presence of strong fields. R.C.Glass

18776 NEUTRALIZATION OF A BEAM OF IONS BY INJECTION OF ELECTRONS. SOLUTIONS INDEPENDENT OF TIME.

J.M.Dolique.
C.R. Acad. Sci. (France), Vol. 253, No. 5, 818-20 (July 31, 1961).
In French.

Derives steady-state solutions of partial differential equations based on the Fokker—Planck equation, Maxwell's equations and the electron—ion collision frequency. See also following abstract.
C.G.Morgan

18777 NEUTRALIZATION OF A BEAM OF IONS BY INJECTION OF ELECTRONS. GENERAL TIME-DEPENDENT SOLUTIONS.

J.M.Dolique.
C.R. Acad. Sci. (France), Vol. 253, No. 9, 1091-3 (Aug. 28, 1961).
In French.

The work begun in a preceding note (see preceding abstract) is continued by quoting a formula for the charge density u as a function of time t and distance z from the plane of injection. The formula contains two arbitrary functions of time, $u_0(t)$ and $i_0(t)$, representing the charge density and current density at the plane of injection. If $u_0(t) = 0$ and $i_0(t) = \text{const.}$, then $u(z,t)$ oscillates with ever-increasing amplitude. If the ion velocity at $z = 0$ exceeds the electron thermal velocity, then a neutralized beam can, however, be produced by oscillating $u_0(t)$ sufficiently rapidly.
O.Penrose

18778 ON RESONANT CHARGE TRANSFER IN IONIZED DENSE GASES.

I.Popescu.
Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 584-7 (Oct., 1961).

When a feebly ionized gas is compressed until the mean distance between atoms decreases down to approximately less than ten times an atomic radius, the positive charge is not carried by the ion in motion but rather jumps resonantly from atom to atom. This statement is arrived at by comparing the mean time of flight of the positive ion between two collisions with the resonant transfer time of the electron from the atom to the next positive ion.

18779 EXPERIMENTAL INVESTIGATION OF ELECTRON CAPTURE BY MULTIPLY-CHARGED IONS.

V.S.Nikolaev, I.S.Dmitriev, L.N.Fateeva and Ya.A.Teplova.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 989-1000 (April, 1961).
In Russian.

The electron capture cross-sections $\sigma_{i,i-1}$ of multiply charged light ions having charge i and atomic numbers Z from 2 to 18 were determined for ions moving with velocities $v = (2.6 - 12) \times 10^8$ cm/sec in helium, nitrogen, argon and krypton. Approximately the same dependence of $\sigma_{i,i-1}$ on v was found for all ions in a given gas. A correlation was found between the cross-sections in different gases and the numbers of electrons in specified shells of the gas atoms. Minima in the dependence of $\sigma_{i,i-1}$ on Z were found for low-charge ions. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 695-702 (Oct., 1961)].

18780 DOUBLE CHARGE EXCHANGE OF ALKALI METAL IONS.

Ya.M.Fogel', V.F.Kozlov and G.N.Polyakova.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1186-92 (Nov., 1960). In Russian.

Experimental data on double charge exchange of Li^+, Na^+, and K^+ ions in a number of gases are presented which confirm the possibility of using Massey's adiabatic hypothesis to account for the shapes of the $\sigma_{1-1}(v)$ curves. Conclusions are stated regarding the behaviour of some of these curves of $v < v_{max}$ near v_{max}. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 826-30 (May, 1961)].

ELECTRIC DISCHARGES

18781 THE INFLUENCE OF THERMOELECTRIC EFFECTS ON THE MAXIMUM TEMPERATURE IN A RADIALLY CONSTRICTED GAS DISCHARGE BETWEEN ELECTRODES.

P.W.Seymour.
Austral. J. Phys., Vol. 14, No. 2, 279-94 (June, 1961).

In an earlier paper (Abstr. 8332 of 1961) the author provided a method for estimating the maximum temperature in a steady-state, centrally constricted, highly ionized deuterium discharge between electrodes. The analysis applied to discharges not too long, so that bremsstrahlung loss could be neglected compared to the main heat loss by conduction to the electrodes, and thermoelectr
effects were not included. Here the analysis is generalized to include thermoelectric effects, and carried through for strictly longitudinal flow, for which at every point within the discharge th
heat flux vector $\vec{q}$ and the current density vector $\vec{j}$ are parallel
the magnetic field $\vec{H}$. Again a simple continuity argument shows
that $\vec{q} + V\vec{j} = 0$, where V is the electric potential, but now the equipotential surface on which $\vec{q} = V = 0$ is displaced from midwa
between the electrodes nearly to the cathode. In the linear case
the maximum temperature is displaced somewhat from the midw
position towards the anode. A similar remark applies to the con
stricted discharge. The important influence of inclusion of therr
electric effects is that the maximum temperature is increased b
approximately 14% for about the same applied voltage producing
given current in a particular discharge geometry. The characte
istic relating to the maximum temperature and resistance ratio
and the radial compression ratio ν obtained on the earlier paper
not changed by thermoelectric effects. Comparison of voltage a
also temperature versus distance characteristics for linear and
constricted discharges without and with thermoelectric effects i
given by means of graphs.

18782 A STABILITY CRITERION FOR A RADIALLY CONSTRICTED GAS DISCHARGE BETWEEN ELECTRODES.

P.W.Seymour.
Austral. J. Phys., Vol. 14, No. 3, 321-34 (Sept., 1961).

The stability of a centrally constricted, highly ionized deute
discharge between electrodes is considered. Initially, the norm
mode and energy principles for the examination of plasma stabil
ty are reviewed and the results contrasted. Teller's powerful stability criterion is next obtained in a useful integral form by means of a thermodynamic analysis of interchange instability. This general geometrical result is then applied to a centrally constricted plasma between electrodes, and a sufficient stability
criterion is derived. For this type of system, initially stablized
a strong, external guiding magnetic field, it is found that the ons
of instability occurs for a $I_0^*(w_b) \sim 1{\cdot}6\varphi_E/z_e$, where φ_E from th
external solenoid is the total flux through any discharge equipot
tial surface, z_e is the discharge semi-length, and practical simp
fying assumptions of high radial compression ratio ν and maxim
discharge radius $\rho_1 \sim < \frac{1}{5} z_e$ are made. It is suggested that experi
mental confirmation of the above result would justify a more det
stability analysis.

18783 EXCITATION OF ACOUSTIC WAVES BY INTERACT BETWEEN CHARGED PARTICLES AND NEUTRAL MOLECULES IN A DISCHARGE TUBE.

J.Briand, J.L.Delcroix and M.L.Fânzeres de Castro Fernandes.
C.R. Acad. Sci. (France), Vol. 253, No. 5, 824-6 (July 31, 1961).
In French.

Gives details of a study of the production of acoustic waves
produced by momentum transfer collisions in a low pressure, lo
frequency gas discharge.
C.G.Mo

18784 ON MICROWAVE CONDUCTIVITY, NOISE, AND OSCILLATION OF GAS DISCHARGE PLASMA.

P.Jääskeläinen.
State Inst. Tech. Res. Publ. (Finland), No. 56, 24 pp (1960).

A brief theoretical introduction, followed by experimental
measurements of microwave attenuation using a discharge tube
(2 cm diameter with 12 cm electrode separation and a gas filling
identical with that of fluorescent lamps) in a helix line. The effective noise temperature and the electron mean free path are calculated from results. The visual appearance of the discharge
with and without plasma oscillations is discussed.
J.Du

18785 ON THE THEORY OF SHOCK WAVE PROPAGATION AND CHANNEL FORMATION IN STRONG SPARK DISCHARGES.

H.Morgenroth, H.Hess, K.Kischel, K.Rademacher and K.Seliger.
Ann. Phys. (Germany), Vol. 8, No. 3-4,175-88 (1961). In Germa

The expression given by Drabinka (Abstr. 6985 of 1951) for
the velocity of shock waves produced by strong spark discharges
is extended to any symmetry condition. The two dimensional ca
is fully discussed with respect to experiment. By taking approp
special cases for the energy function occurring in the general
expression, the experimentally determined maximum in the shoc
wave propagation velocity can be obtained. Some observations o
the theory of channel formation are given.
J.W.Stur

8786 EXPERIMENTS ON SPARK DISCHARGES IN T-SHAPED DISCHARGE TUBES.

ess, K.Kischel, H.Morgenroth, K.Rademacher and K.Seliger.
. Phys. (Germany), Vol. 8, No. 3-4, 189-95 (1961). In German.

Oscillographic measurements of current and voltage in argon reported together with photographs of shock wave propagation n with a streak camera. The initial pressure in the discharge was varied between 0.2 and 500 torr. Power and energy were ulated from the oscilloscope measurements; the streak camera the shock velocity as a function of time and position. It was d that the energy dissipated up to the first current maximum e spark was pressure dependent and had a minimum value at t 5 torr. The variation of shock velocity with time, the tion between the appearance in time of the maximum in power the shock velocity and the dependence of the maximum shock city on pressure are compared with the work of Kolb (Abstr. of 1958) and Morgenroth (see previous abstract). The model l in the latter paper allows a satisfactory interpretation of the lts. J.W.Sturgess

18787 THEORY OF SHOCK WAVE PROPAGATION AND DISCHARGE CHANNEL DEVELOPMENT IN STRONG RK DISCHARGES.

orgenroth, H.Hess, K.Kischel, K.Rademacher and K.Seliger.
atsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, 11, 653-8 (1960). In German.

The formula due to Drabkina for the velocity of shock waves urring with strong spark discharges is extended by taking into sideration certain conditions of symmetry. By suitable cialization of the energy function appearing in the general nula, the experimental maximum velocity of the shock wave be obtained theoretically. Comments are also given on the ory of channel development. H.Edels

18788 IGNITION OF GAS BY SPARKS PRODUCED BY BREAKING WIRES AT HIGH SPEED.

Gordon, H.Lord and D.W.Widginton.
ure (GB), Vol. 191, 1085-6 (Sept. 9, 1961).

Minimum igniting currents of 110 mA were obtained by breaking atively bulky wire (diameter 0.012 in.) at separation speeds of 0 cm sec^{-1}. C.G.Morgan

18789 ACCELERATION OF POSITIVE IONS IN EXPANSION OF THE PLASMA IN A VACUUM SPARK. A.A.Plyutto.

eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1589-92 (Dec., 1960). ussian.

Acceleration of positive ions to energies of 10^3-10^4 eV was cted in the rapid expansion of the plasma in a vacuum spark. rief description is given of a mechanism capable of explaining experimental facts; this mechanism involves the acceleration ons by electrons. [English translation in: Soviet Physics—JETP A), Vol. 12, No. 6, 1106-8 (June, 1961)].

8790 CHANNEL EXPANSION IN SMALL INTENSE SPARKS. B.A.Demidov, Yu.F.Skachkov and S.D.Fanchenko.

eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 385-90 (Feb., 1961). ussian.

An electron-optical chronograph was used to study the initial es of channel expansion in sparks in oxygen and nitrogen ressures up to 10 atm), in deuterium (13 atm) and in hydrogen to 20 atm) produced by discharging low-inductance capacities 0 and 6300 μμF. The maximum rate of rise of the current is e order of 3×10^{12} A/sec, the calculated peak current roximately 10^3 A, and the calculated current density 10^8-10^9 m^2. The initial expansion of the spark channel is due to a ndrical shock wave which propagates at a velocity up to 10^6 cm/sec in nitrogen, up to 8×10^6 cm/sec in hydrogen and o 7×10^6 cm/sec in deuterium (in the last case the temperature e shock wave front is approximately 8 eV). The calculated perature in the spark channel in hydrogen is approximately V. [English translation in: Soviet Physics—JETP (USA), . 13, No. 2, 263-6 (Aug., 1961)].

18791 TRANSFORMATION OF THE TORCH DISCHARGE INTO HIGH FREQUENCY CORONA. V.Trunecek.

ch. J. Phys., Vol. 10, No. 12, 960-5 (1960). In German,

Experiments are described of a high frequency discharge 5 Mc/s), in air at atmospheric pressure. At low currents the harge was high frequency corona and spectra indicated the tence of field ionization. With increasing current the corona was transformed into a torch discharge, in which ionization was produced thermally. By artificially lowering the temperature of the torch (e.g. by gas flow) the reverse transition could be produced. H.Edels

18792 GROUP VELOCITY OF MOVING STRIATIONS IN Hg—A DISCHARGE. H.Yoshimoto and Y.Yamashita.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1649-50 (Aug., 1961).

A development of the work of Wojaczek (Abstr. 4647 of 1959) is reported wherein the measurements are carried into the current region in which natural moving striations can appear. Perturbations, in the form of wave-packets, were produced by current pulses at the negative end of the positive column, and these propagated towards the anode. The behaviour of these wave-packets in the various current regions is described. M.Kasha

18793 THE TEMPERATURE DEPENDENCE OF CERTAIN PROCESSES WHICH ARE DETERMINED BY ELASTIC COLLISIONS BETWEEN ELECTRONS AND ATOMS. K.Wojaczek.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 1, 12-15 (1960). In German.

In low pressure discharge positive columns, many elementary processes are determined by coefficients which are in turn determined by collision cross-sections and their variation over the velocity distribution. Assuming elastic collisions and Maxwellian conditions, the paper gives expressions for the number of elastic collisions, electron mobility, coefficients of diffusion, thermal diffusion and electron heat conductivity and transferred kinetic energy. Taking appropriate values for argon, the calculation of mobility agrees well with observation. H.Edels

18794 PROBE MEASUREMENTS AND DETERMINATION OF ELECTRON MOBILITY IN THE POSITIVE COLUMN OF LOW-PRESSURE MERCURY—ARGON DISCHARGES.

W.Verweij.
Philips Res. Rep. Suppl. (Netherlands), No. 2, 112 pp. (1961).

The electron concentration and its radial distribution, the electron temperature, and the axial field strength were measured by means of very thin cylindrical electric probes for a large number of values of the current (0-800 mA), argon partial pressures (0-20 mm Hg), and mercury-vapour partial pressures (0.5×10^{-3}-90×10^{-3} mm Hg). Precautions were taken to eliminate oscillations at the electrodes and moving striations. The electron velocity distribution was found to be Maxwellian over an energy range of ~4 eV. It is concluded that probe measurements can be useful in the investigation of the low-pressure discharge positive column and that the electron mobility can be satisfactorily calculated from the collision cross-sections of the gas atoms present according to the Lorentz electron theory. I.C.Demetsopoullos

18795 THE TRANSIENT GROWTH OF CURRENTS IN A TOWNSEND GAS DISCHARGE UNDER UNIFORM FIELD. R.Kluckow.

Z. Naturforsch.(Germany), Vol. 16a, No. 6, 539-47 (June, 1961). In German.

The growth under uniform d.c. field conditions is calculated by means of the theory given by Auer (Abstr. 3532 of 1959). Three cases are examined in detail: (1) the discharge is initiated by a short u.v. light pulse releasing a great number of electrons from the cathode; (2) the discharge is started by a single electron; (3) the discharge develops under constant external illumination producing a great number of electrons within a period of an electron transit time. Earlier experimental work is discussed on the basis of the calculated relations.

18796 NOTE ON THE POSITIVE COLUMN IN MIXTURES OF IODINE AND ARGON.

G.A.Woolsey, R.Seymour, K.G.Emeleus and J.R.M.Coulter
J. Electronics and Control (GB), Vol. 9, No. 6, 467-71 (Dec., 1960).

Three types of positive column have been obtained in low-pressure discharges through a mixture of an inert and an electronegative gas. For small currents striations form which are bowed axially in the opposite sense to that usually found. With increase in current these develop axial protruberances which blend to give either a stationary or a mobile constricted column. The effects described so far are time averages.

18797 PROBE MEASUREMENTS AT HIGHER CURRENTS IN THE POSITIVE COLUMN OF AN ARGON DISCHARGE.

E.Hayess and K.Rademacher.

Ann. Phys. (Germany), Vol. 8, No. 3-4, 158-74 (1961). In German.

An investigation is described in which probes are used in an argon discharge with current densities between 0.3 and 1.3 Amp cm^{-2} at 0.1 torr in order to ascertain the influence of current density on electron temperature, electron mobility and radial distribution of electron concentration. Using two probes, the axial voltage gradient is determined. Results are given for current values from 16 to 64 A. The radial concentration variation approximates to a Bessel function. The concentration values and mobilities are determined by two methods and satisfactory agreement between the methods is obtained. A detailed analysis of possible errors is given.

H.Edels

18798 ON MOVING STRIATIONS OF LOW-PRESSURE MERCURY DISCHARGES. G.Lakatos and J.Bitó.

Acta phys. Hungar., Vol. 13, No. 2, 193-201 (1961).

The authors examined the propagation velocity of the moving striations appearing in low-pressure Hg vapour discharge tubes in the case of d.c. The influence of the pressure of argon applied besides that of mercury on the mentioned velocity was studied, when the vapour pressure of mercury was kept at an approximately constant value.

18799 THE INFLUENCE OF EXTERNAL RESISTANCE ON THE MOVING STRIATIONS OF THE POSITIVE COLUMN. G.Lakatos and J.Bitó.

Acta phys. Hungar., Vol. 13, No. 2, 245-7 (1961).

The speed of the moving striations, the amplitude of the light intensity oscillations and their wavelength were found to depend upon the ohmic resistance in the external circuit of a low-pressure d.c. arc discharge. The frequency of the oscillations was independent of the external resistance but was influenced by inductance in the external circuit.

G.Carter.

18800 ON THE MECHANISM OF THE CATHODIC PART OF A GLOW DISCHARGE. F.Wächter.

Ann. Phys. (Germany), Vol. 8, No. 1-2, 31-41 (1961). In German.

The way in which the average time spent by a positive ion in the cathode fall, and the number of electrons in front of the cathode, depends on the field distribution in the cathode fall is discussed theoretically. Using this theory and measured values of the field distribution (Abstr. 7087 of 1955) the contribution of ions formed in the negative glow to the maintenance of the discharge is calculated. Consideration of the steady state shows the photoeffect not to be the main source of electron emission.

J.Dutton

18801 CONTRIBUTION OF PHOTOELECTRIC EMISSION FROM CATHODE TO SECONDARY PROCESSES IN A SELF-MAINTAINED COLD CATHODE GLOW DISCHARGE.

V.T.Chiplonkar and S.A.Nadkarni.

J. sci. industr. Res. (India), Vol. 20B, No. 7, 342 (July, 1961).

Experiments designed to investigate the importance of photoemission from the cathode as a secondary process in the cold-cathode glow discharge are reported. Discharges in air and in hydrogen were studied using cathodes of the same material but of different area so as to produce photocurrents of different magnitudes. The results indicate that cathode photoemission is of little significance in the normal range of the discharge, but may be of importance in both abnormal and obstructed discharges. The conclusions agree with those of Little and von Engel (Abstr. 7469 of 1954).

C.H.B.Mee

18802 SPACE-CHARGE DENSITY IN THE DARK SPACE OF A COLD CATHODE GLOW DISCHARGE AND ITS DEPENDENCE ON DISCHARGE CURRENT.

V.T.Chiplonkar and S.B.Joshi.

J. sci. industr. Res. (India), Vol. 20B, No. 9, 447-8 (Sept., 1961).

From studies on air and hydrogen, in the pressure range 50-1000 microns, it was observed that the space-charge density in the cathode dark space shows a significant variation with the discharge current as the discharge approximates to the normal regime, whereas the variation becomes insignificant for the abnormal region of the discharge.

18803 THE INFLUENCE OF THE CATHODE REGION BOUNDARY ON THE VOLTAGE AND CURRENT DENSITY OF A GLOW DISCHARGE. L.Rothhardt.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No.
587-90 (1960). In German.

The wall-free glow discharge operates with voltages and current densities lower than the normal wall-bounded glow. Consideration of the balanced radial transport processes which must occur in a stable discharge indicate the explanation of this effect.

H.Ede

18804 HIGH-VOLTAGE GLOW DISCHARGES IN D_2 GAS. I. DIAGNOSTIC MEASUREMENTS. G.W.McClure.

Phys. Rev. (USA), Vol. 124, No. 4, 969-82 (Nov. 15, 1961).

Pulsed glow discharges in D_2 gas at currents of the order of
and voltages in the range 40-80 kV were experimentally examine
to determine the mass and energy distribution of ions incident on
the cathode, the secondary electron emission due to various
particles incident on the cathode, the energy spectrum of the
electrons on the anode, the potential distribution along the glass
walls, and the temperature and density of the electrons in the pla
which develops in the anode end of the discharge. The experimental results are discussed together with available cross-sectio
data from the literature to establish the relative importance of
the various collision processes which contribute to the sustainme
of the discharge. Several processes peculiar to the extremely
high operating potential (not of particular importance in ordinary
glow discharges) are shown to assume dominant roles. These
include electron backscattering from the anode, ionization of the
gas by fast ions and fast neutral atoms, and ionization in the plas
region due to the secondary electrons released from the glass wa
The necessity of a complete revision of the usual theoretical poin
of view regarding electron ionization in the cathode region of the
discharge and in the anode (plasma) region is indicated.

18805 TOTAL RADIATION OF A STATIONARY AND SUPER IMPOSED HIGH-TEMPERATURE ARGON ARC.

W.Neumann.

Beitr. Plasma Physik (Germany), Vol. 1, No. 2, 107-18 (1960-61).
In German.

The total radiation power is determined as a function of the
power of the arc, with the arc both stationary and with a capacito
discharge impulse superimposed. Under impulse conditions phot
graphs show the release of particles from the electrode, the parti
having velocities of metres/second. With the high current impuls
the results show a fall off in radiation which may be due to increa
loss of heat by gas flow. The volt—ampere characteristic is give
for the discharges. From measurements of the radiation continu
and line emission the radial temperature variation of the stationa
180 ampere arc is evaluated.

H.Ed

18806 TOTAL RADIATION OF THE STATIONARY AND IMPULSE-LOADED ARGON HIGH-TEMPERATURE ARCS. W.Neumann.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No.
340-3 (1960). In German.

The total radiation output was measured for 10 mm long arg
arcs up to 500 A and at higher currents by using an added conden
impulse discharge of 100 μsec. The radiation was measured wit
a vacuum thermoelement and the electrical energy measured wit
a ballistic device. The results are described in terms of a facto
which is the differential of radiation to electrical power, and for
steady arc this factor reaches a maximum of ~ 14%. The impuls
loaded arc has higher values of η but η reduces with increasing
load.

H.Ed

18807 PROBE MEASUREMENTS AT HIGH CURRENT DENSITIES IN A LOW PRESSURE ARGON DISCHARG

E.Hayess and K.Rademacher.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 11, 650-3 (1960). In German.

The radial variation of electron temperature, charge
concentration and plasma potential, and the positive column poten
gradient, were measured. The results are evaluated by Langmui
method and also by a method devised by Kagan using the ion curr
portion. Both methods agree well. The case of a 48 A discharge
was considered, for current densities in the range 0.3 to 1.3
A/cm^2 at 0.1 torr. The results show a radial Bessel distribution. The derivation of the mobility agrees with previous work
despite a current density 30 times greater.

H.Ed

18808 A THEORY OF COLD-CATHODE ARC MOVEMENT IN A MAGNETIC FIELD. P.E.Secker and A.E.Guile.
ıre (GB), Vol. 190, 428-9 (April 29, 1961).

In a cold-cathode arc at high pressures ($\sim$ 1 atm) motion of the
in a magnetic field occurs in the Amperian direction. This
ion is controlled by conditions at the cathode. The cathode fall
hich a field emission mechanism is operative is divided into a
e-charge zone, a transition zone and a contraction zone. In
transition zone the emitted electrons suffer many elastic
isions so that their drift velocity is low and the magnetic field
le to deflect the electrons in the Amperian direction. The
ors give expressions for the extension of the transition zone
for the electron deflection. Consideration is also given to the
lictions of the theory as pressure is reduced and the manner in
h the transition to retrograde motion is approached.

H.Edels

8809 RADIO-FREQUENCY BREAKDOWN CONTROLLED BY DRIFT OF ELECTRONS IN AN INHOMOGENEOUS
GNETIC FIELD. L.T.Shepherd and H.M.Skarsgard.
ad. J. Phys., Vol. 39, No. 7, 983-92 (July, 1961).

A study has been made of r.f. breakdown in which the controlling
mechanism arises from the drift of electrons in an inhomo-
eous magnetic field. The study was carried out using a torroidal
em with parallel r.f. electric and steady magnetic fields. An
oximate average-electron theory of drift-controlled breakdown is
sented. Experimental measurements of breakdown r.f. electric
l verus magnetic field were made at various pressures from 1.25
0×10^{-3} mm of Hg, using hydrogen and helium gases. A radio
uency of 8 Mc/s was used. Magnetic fields up to 2000 gauss
e employed. The r.f. breakdown field was found to vary as the
rse square root of the magnetic field as predicted by the theory.

8810 NEW DERIVATION OF THE VACUUM BREAKDOWN EQUATION RELATING BREAKDOWN VOLTAGE AND
CTRODE SEPARATION. A.Maitland.
ppl. Phys. (USA), Vol. 32, No. 11, 2399-2407 (Nov., 1961).

An analysis of the published measurements of breakdown voltage
various gap lengths and uniform and approximately uniform fields
vs that they may be represented by the breakdown equation
Cx^{α} and that the values of α lie in the range 0.1 to 1.1 with a
e of 0.7. A theory is developed which leads both to a breakdown
tion of this form and to a general expression accounting for the
ge of values of α. This expression is confirmed for gaps up to
5 cm by direct experiment. The development is based on the
ulate that an electron beam is emitted from the cathode,
rges, and bombards the anode to cause breakdown when a
ical power flux is reached. The factor C is shown to include the
ical power flux and to be related to both field and electrode
ration. In support of the theory, the radii of craters produced
e anode are measured and shown to be related to the radius of
lectron beam at the anode. Calculation shows the current
ied by the beam to be of the order of 10^{-4} A. Values of the
ical power flux obtained from the equation $V = Cx^{\alpha}$ and from
le crater data agree within a factor of 1.5 and are of the order
0^{8} W cm^{-2}. To explain the observed phenomena, a multiple
tron beam system is proposed.

18811 TRANSIENT BREAKDOWN STUDIES IN HYDROGEN AT LOW VALUES OF E/p.
ssin, D.E.Golden and L.H.Fisher.
s. Rev. (USA), Vol. 124, No. 4, 993-5 (Nov. 15, 1961).

Formative time lag measurements of uniform field breakdown
e carried out in hydrogen for products of pressure p and
trode separation d ranging from 100 to 1300 cm × mm Hg. This
ange corresponds to a region of electric field strength E
ded by p at the breakdown threshold of between 21 and 32 V
mm Hg)$^{-1}$. The formative time lags decrease from about
ısec at several hundredths of a percent overvoltage to fractions
microsecond for overvoltages greater than 5%. The results
cate that the secondary mechanism active is photoelectric
ssion from the cathode.

18812 EQUIVALENT PRESSURE CONCEPT IN CROSSED ELECTRIC AND MAGNETIC FIELD IN ELECTRODE-
S DISCHARGE. S.N.Sen and A.K.Ghosh.
an J. Phys., Vol. 35, No. 2, 101-4 (Feb., 1961).

Breakdown potential measurements in air in crossed electric
magnetic fields for the pressure range 1×10^{-3} to 1 mm Hg
used to calculate the equivalent pressure P_e. Graphs of P_e/P against P are plotted for two expressions for P_e; in both cases P_e/P tends to a constant value at high gas pressures. It is noted that the effect of magnetic field on breakdown potential is dominant at high pressures.

W.G.Townsend

18813 BREAKDOWN IN HYDROGEN IN THE LOW (p.d.) RANGE. G.Schmitz and H.Niesters.
Z. Phys. (Germany), Vol. 164, No. 4, 409-15 (1961). In German.

Describes investigations on the dependence of the breakdown voltage upon the external current in a hydrogen low pressure discharge. Values of the change in breakdown voltages are obtained in the p.d. range 1.05-0.054 torr cm. The breakdown voltage minimum was found in hydrogen with platinum electrodes at p.d. 1.04 torr cm to be 294 V. The measurements taken in the p.d. range below that corresponding to the voltage minimum were obtained by the use of specially designed tube and electrode systems. From the results it is shown that the relative change of breakdown voltage is proportional to the square root of the current produced by external means. Thus the square root law holds for p.d. values over the whole range of spark breakdown voltages.

H.Edels

ELECTRICAL BREAKDOWN OF LIQUID DIELECTRICS.
See Abstr. 18423

18814 EXPERIMENTS ON THE TRANSPORT OF MATTER IN MAKE AND BREAK CONTACTS USING RADIO-ACTIVE ISOTOPES. I.Dietrich and M.Honrath-Barkhausen.
Z. angew. Phys. (Germany), Vol. 12, No. 12, 538-44 (Dec., 1960). In German.

Transport measurements were made using contacts made from various metals. The contributions of the bridge and the arc to the transport is discussed. The authors consider that their results are in agreement with previous work on the nature of the liquid bridge.

P.M.Davidson

PLASMA

(See also Magnetohydrodynamics)

18815 STATISTICAL THERMODYNAMICS OF PLASMAS. H.S.Green.
Nuclear Fusion (Internat.), Vol. 1, No. 2, 69-77 (March, 1961).

A systematic method for the computation, with arbitrary accuracy, of the thermodynamic functions of a gaseous plasma is developed from first principles. The theory of the grand partition function is used to derive a set of exact integral equations, which determine the electronic and ionic distribution functions. An approximate solution of these equations yields results similar to those of the Debye—Hueckel theory of electrolytes. More exact solutions are developed and used to compute the equation of state and other thermodynamic functions for plasmas.

18816 AVERAGE KINETIC ENERGY OF DIFFUSING PARTICLES IN DISCHARGE AND ELECTRON TUBES.
M.A.Cayless.
Brit. J. appl. Phys., Vol. 12, No. 9, 523-4 (Sept., 1961).

The author derives the value 2 kT for the mean kinetic energy carried by particles with a Maxwellian distribution and shows that the value $\frac{3}{2}$ kT, often used for this energy, results from a simple perturbation of the Maxwellian distribution. These results are then applied to energy balance conditions between a plasma and an electrode.

G.Carter

18817 ELECTRON DENSITY DISTRIBUTION IN A CYLINDER. H.D.Weymann.
Z. angew. Math. Phys. (Switzerland), Vol. 12, No. 1, 82-6 (Jan. 25, 1961).

A theoretical paper on a problem related to electron diffusion in shock waves generated in cylindrical shock tubes. The author calculates the quasi-equilibrium radial distribution of diffusing electrons in an ion-free gas contained in an infinite cylinder as a function of cylinder radius, electron density and temperature.

M.McChesney

18818 STABILITY CONDITIONS ON THE ELECTRON DISTRIBUTION FUNCTION FOR A PLASMA.

A.I.Akhiezer, G.Ya.Lyubarskii and R.V.Polovin.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 963-9 (March, 1961), In Russian.

General conditions for the stability of the function with respect to high-frequency plasma oscillations are deduced neglecting collisions. A free plasma and a plasma immersed in a constant, uniform electric or magnetic field are considered. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 673-6 (Sept., 1961)].

18819 DENSITY FLUCTUATIONS IN A PLASMA IN A MAGNETIC FIELD, WITH APPLICATIONS TO THE IONOSPHERE.

T.Hagfors.
J. geophys. Res. (USA), Vol. 66, No. 6, 1699-1712 (June, 1961).

General expressions are developed for the fluctuation in density of electrons, ions, and charge in a plasma in thermal equilibrium in an external magnetic field taking only Coulomb interaction into account. The spectral distribution of the spatial Fourier components of these fluctuations is derived from basic principles. The fluctuations in electron density are discussed in some detail, and spectra are computed under conditions that are thought to prevail in the outer ionosphere. Frequency spectra of general validity are computed for electron-density fluctuations along the magnetic field. It is shown by means of examples that the frequency spectra under ionospheric conditions are little influenced by the magnetic field except for density fluctuations fairly close to perpendicularity to the magnetic field. Applications to incoherent backscattering are discussed, and it is shown that, under suitable conditions, backscatter techniques can give valuable information about electron density, temperature, and constituents of the ionosphere. (See also following abstract).

18820 FLUCTUATIONS IN A MULTICOMPONENT PLASMA.

O.Buneman.
J. geophys. Res. (USA), Vol. 66, No. 6, 1978-9 (June, 1961).

Hagfors' theory (see preceding abstract) is generalized to apply to a multicomponent plasma. The fluctuation spectrum of a $H^+ : O^+ : e^-$ plasma is plotted, showing distinct resonance maxima at the gyrofrequencies of both H^+ and O^+. This confirms that comparison with observations can yield data on the actual ion concentrations at various levels of the ionosphere. D.M.Gilbey

18821 VALUES OF THE TRANSPORT COEFFICIENTS IN A PLASMA FOR ANY DEGREE OF IONIZATION BASED ON A MAXWELLIAN DISTRIBUTION.

I.P.Shkarofsky.
Canad. J. Phys., Vol. 39, No. 11, 1619-1703 (Nov., 1961).

Values are presented of the electronic conductivity for any degree of ionization, radio frequency, and d.c. magnetic field strength, and various electron speed power law variations of the electron collision frequency with neutral particles. Also, the other transport coefficients, such as electron current due to electron density gradients and temperature gradients, and energy flow due to an electric field and due to density gradients and temperature gradients, are tabulated. The analysis is based on substitution of the usual series expansion of Laguerre polynomials into the Fokker—Planck equation for Coulomb collisions and into the Boltzmann equation for electron collisions with neutral particles. For Coulomb effects, the expressions are the same as those derived by Landshoff (1949). Collisions of electrons with neutral particles are included in addition to ions, and a.c. electric fields are treated as well as d.c. magnetic fields. In the limit of a completely ionized gas, the results also agree with those of Spitzer and Harm (1953) and of Kaufman. For a slightly ionized gas, the results are compared with Allis' treatment (1956) and with calculations using the Dingle integrals. It is found that the Laguerre convergence is inadequate for large angular frequencies when the power law is less than −2 and for small angular frequencies when the power law is greater than 1. The final results can be put in a form which yields two factors, multiplying, respectively, the average collision frequency and radian frequency, to give correct results from simple equations. These factors are usually of order one, and are functions of three parameters, proportional to angular frequency, ratio of electron-neutral to ion averaged collision frequency, and ion charge number.

18822 EFFECT OF NEUTRAL PARTICLES ON THE TRANSPORT PROPERTIES OF A PLASMA IN A UNIFORM MAGNETIC FIELD.

J.P.Wright.
Phys. of Fluids (USA), Vol. 4, No. 11, 1341-7 (Nov., 1961).

The effect of neutral particles on viscosity, heat flow, curre
and drift in an ionized plasma is derived. The effect of neutrons
a hydrogen plasma in a strong uniform magnetic field is calculate
The effect begins to be significant at a temperature of approximat
10 keV, depending on the values of other variables.

ELECTRICAL CONDUCTIVITY OF A PLASMA.

See Abstr. 17660

18823 CORRELATION OF THE ELECTRIC FIELD IN A PLASMA.

I.Fidone.
Nuovo Cimento (Italy), Vol. 20, No. 6, 1219-23 (June 16, 1961). In French.

An improvement of a calculation of the electrical resistance of a plasma by Taylor (Abstr. 17011 of 1960). Taylor treats the electrons as independent in his calculation of the electric field correlation function, but this paper takes account of the spatial correlations of the electrons according to the Debye theory.

H.N.V.Temperle

18824 A SIMPLIFIED ANALYSIS OF THE DYNAMICS OF PLASMA GUNS.

J.G.Linhart.
Nuclear Fusion (Internat.), Vol. 1, No. 2, 78-81 (March, 1961).

Deals with the acceleration of a cylindrical layer of plasma
an azimuthal magnetic field; a process similar to the ordinary $B_\varphi I_z$ pinch. The magnetic field is generated by a current drawn from a condenser. The system can be represented by an LC circuit in which the value of the inductance is changing owing to t
movement of the plasma conductor. A simple but approximate description of the acceleration of the plasma can then be derived using the adiabatic theorem for oscillators together with the law of conservation of energy. The resulting approximate solutions a
compared with numerical solutions of the appropriate differential equations. The approximate solutions are also applied to a rail-t
of plasma gun previously reported by Artsimovich et al. (Abstr.
3262 of 1958).

18825 VOLTAGE CHARACTERISTICS OF A ROTATING PLASMA.

B.Lehnert.
Nuclear Fusion (Internat.), Vol. 1, No. 2, 125-30 (March, 1961).

The balance of forces is investigated for a rotating plasma contained in a long cylindrical vessel and placed in an axial magnetic field. A relation is deduced between the voltage which arises in a radial direction in the plasma and the electric charge being transmitted through the system from an external source. It is found that the equivalent capacity, which describes the electrical behaviour of the plasma, depends upon the transmitted charge and upon the constitution of the vessel wall. An explanation is suggested for the voltage limiting effect earlier observed in the Ixion device.

18826 THE DAMPING OF RAYLEIGH—TAYLOR INSTABILITIES IN A THETATRON DISCHARGE.

H.A.B.Bodin, A.A.Newton and N.J.Peacock.
Nuclear Fusion (Internat.), Vol. 1, No. 2, 139-43 (March, 1961).

A high-speed framing camera was used to photograph deuterium and helium discharges in which flute instabilities were driven by the inertial force of a radial acceleration. The wavelength of the instability increased with decreasing initial pressur
suggesting the damping effect of viscosity; in some cases this damping apparently prevents the growth of flutes entirely. A simple theory of viscous damping is in qualitative agreement wit
the observations. An instability due to the radial acceleration accompanying a rotation of the plasma appeared at about peak fie

18827 FISSION OF A HOT PLASMA.

N.Rostoker and A.C.Kolb.
Phys. Rev. (USA), Vol. 124, No. 4, 965-9 (Nov. 15, 1961).

It has been observed that the plasma formed in a fast B_z compression develops an instability after about a 4 to 5μsec quiescent period. The consequence of the instability is that the plasma fissions into two well-defined filaments that rotate with a
angular velocity $\Omega \sim 10^7$ sec^{-1}. This configuration was observed for many rotational periods. The plasma appears to remain confined, although impurity radiation indicates that some plasma reached the walls during the fission process. The fission proces
in a deuterium plasma is accompanied by a rapid decline in neutr
production. The origin of the rotation and the development of the instability are discussed.

8828 **SYNTHESIS AND PROPERTIES OF AN ELECTRON—ION PLASMA.** A.von Engel and R.N.Franklin.
c. Roy. Soc. A [GB], Vol. 264, No. 1318, 355-66 (1961).

It is shown that a low-density neutral plasma in a steady state,
sisting of electrons and ions only, can be obtained by injecting
sing beams of charges into a field-free region. With the aid of
trostatic probes the electric neutrality of such a synthetic
ma can be controlled. Experiments were carried out with a
ma consisting of singly charged lithium ions of energy up to
eV drawn from a lithium—aluminium silicate emitter and
trons of energy 12 to 24 eV drawn from a dispenser cathode.
residual gas pressure was kept so low that collision with atoms
not contribute to the effects measured. A continuous electric
al of frequency 2 to 30 Mc/s was transmitted through the plasma.
reas in a gaseous plasma a resonance peak at the plasma
uency was found by varying either the signal frequency or the
harge current (and thus the plasma frequency), a resonance
rption was recorded in an electron—ion plasma. This suggests
for frequencies lower than that corresponding to an individual
tron crossing the region of influence of the signal the phase of
electron oscillation always tends to reduce the local field. As
electron velocity was raised the magnitude of absorption was
wn to grow. The transmission in the electron—ion plasma was
studied with a magnetic field parallel to the direction of the
ms which caused the electrons to circulate about the field lines.
varying the field strength the absorption was found to reach a
imum when the electron cyclotron frequency equals the plasma
uency. The width of the absorption curves for the electron—
plasma was greater than that with an electron beam only. The
raction between ions and electrons was demonstrated by
suring the electric noise produced by the plasma. For electron
rgies between 10 and 70 eV the increase in noise corresponds to
ange of the electron temperature by 400 to 500°K or to an
rage scattering angle of 1 to 3°.

8829 **THE EFFECTIVE IONIZATION POTENTIAL OF ATOMS IN THE INTERIOR OF A PLASMA.**
.Duclos and A.B.Cambel.
Naturforsch. (Germany), Vol. 16a, No. 7, 711-12 (July, 1961).

The validity of the expression proposed by Ecker and Weizel
str. 4425 of 1956) for the electrostatic contribution to the
rnal energy of a plasma is discussed. One part of the expres-
appears valid for high electron densities of greater than
ut 10^{20} cm^{-3} and the other below this point. J.W.Sturgess

18830 **ON THE THEORY OF RUNAWAY ELECTRONS.** A.V.Gurevich.
eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1296-1308
., 1960). In Russian.

The influence of a relatively weak electric field on the velocity
ribution of plasma electrons in the range of high velocities is
sidered. An expression for the stationary electron distribution
tion is obtained and analysed. The magnitude of the flux of
away electrons in a completely ionized plasma is determined.
effect on this flux of neutral plasma particles is taken into
ount. It is shown that under certain conditions instabilities in the
sma may occur during the development of the discharge which
due to the runaway electron flux. The results obtained are in
litative agreement with experiment. [English translation in:
iet Physics—JETP (USA), Vol. 12, No. 5, 904-12 (May, 1961)].

18831 **ACCURACY OF ADIABATIC INVARIANT OF A PARTICLE IN A HIGH-DENSITY PLASMA.** A.M.Dўkhne.
eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 863-5 (March, 1961).
ussian.

An expression is obtained for the variation of the adiabatic
riant in reflection of a charged particle from a magnetic mirror;
diamagnetism of the plasma is taken into account. The limiting
e of complete expulsion of the magnetic field from the plasma,
responding to high plasma densities, is considered. [English
slation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 605-6
t., 1961)].

8832 **THEORY OF THE INTERACTION OF A CHARGED PARTICLE WITH A PLASMA IN A MAGNETIC FIELD.**
.Akhiezer.
eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 954-62 (March, 1961).
Russian.

The interaction of a nonrelativistic charged particle with an
ctron plasma in a magnetic field is studied by quantum field-theoretical methods. The dielectric constant, frequencies and damping coefficients for the longitudinal oscillations of the plasma in the magnetic field are calculated to first order in e^2. A general formula is obtained for the energy loss of a particle moving through a plasma. The case in which the particle moves with a velocity much greater than the mean thermal velocity of the electrons in the plasma is investigated in detail. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 667-72 (Sept., 1961)].

18833 **STRUCTURE OF THE TRANSITION LAYER BETWEEN A PLASMA AND A MAGNETIC FIELD.** V.P.Shabanskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1058-64 (April, 1961).
In Russian.

The structure of the region in which a plasma beam is reflected by a magnetic field is investigated using the self-consistent microscopic equations of motion for the particles; the structure of the transition layer between a fixed plasma and a magnetic field is also studied. In the first case, corrections are introduced to take account of the polarization which is produced at high velocities of the incident beam. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 746-50 (Oct., 1961)].

18834 **THE EQUATION OF STATE OF PARTIALLY IONIZED HYDROGEN.** L.P.Kudrin.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1134-9 (April, 1961).
In Russian.

A method is proposed for the approximate evaluation of the thermodynamic functions of a partially ionized gas, taking into account deviations from ideality. An equation of state is obtained, together with an ionization formula which is appreciably different from the Saha formula. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 798-801 (Oct., 1961)].

18835 **A KINETIC EXAMINATION OF SOME EQUILIBRIUM PLASMA CONFIGURATIONS.**
A.I.Morozov, and L.S.Solov'ev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1316-24 (May, 1961).
In Russian.

Some one-dimensional plasma configurations, the effective size of which is of the order of the Larmor radius, are considered. [English translation in: Soviet Physics—JETP (USA)].

18836 **TRANSITION RADIATION IN A PLASMA WITH ACCOUNT OF TEMPERATURE.** V.M.Yakovenko.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 385-8 (Aug., 1961).
In Russian.

The transition radiation which arises when a charged particle passes through the boundary of a plasma described by linearized hydrodynamic equations is investigated by taking into account the effect of temperature. [English translation in: Soviet Physics—JETP (USA)].

18837 **PLASMA IN A SELF-CONSISTENT MAGNETIC FIELD.** N.N.Komarov and V.M.Fadeev.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 528-33 (Aug., 1961).
In Russian.

The stationary state of a multi-component plasma with axial symmetry in an external axial magnetic field and in the presence of an azimuthal plasma current is determined by neglecting particle collisions and taking into account the proper magnetic field of the plasma. A Maxwellian velocity distribution is assumed with different longitudinal and transverse temperatures. Finally the plasma is assumed neutral at each point.

18838 **STABILITY OF THE VACUUM—PLASMA BOUNDARY.** E.P.Velikhov.
Zh. tekh. Fiz. (USSR), Vol. 31, No. 2, 180-7 (Feb., 1961).
In Russian.

The equilibrium conditions of a plane layer of plasma containing a frozen inner field in an outer magnetic field, and subjected to external perturbing forces, are studied for various types of boundary configurations. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 6, No, 2, 130-3 (Aug., 1961)]. G.Martelli

18839 **MOVING STRIATION IN MICROWAVE DISCHARGE PLASMA.** M.Takeyama, T.Nakau, S.Yamasaki and T.Isa.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1255 (June, 1961).

It was shown experimentally that a sonic wave can be observed in a stationary microwave discharge plasma if the microwave electric field is perpendicular to the plasma column. No sonic wave is observed if the microwave electric field is parallel to the plasma column. M.Hasan

18840 ACCELERATION OF THE PLASMA OF A DISCHARGE AND PRODUCTION OF STRONG SHOCK WAVES IN A CAMERA WITH COAXIAL ELECTRODES.

S.R.Kholev and D.S.Poltavchenko.

Dokl. Akad. Nauk SSSR, Vol. 131, No. 5, 1060-3 (April 11, 1960). In Russian.

The discharge of a condenser radially between a central rod and the walls of a coaxial cylinder leads to an acceleration of the plasma along the axis and the formation of a strong shock wave. With a 2400 μF condenser at 5 kV, photographic records of shocks through air indicate Mach numbers up to 248, giving a temperature of 130 000°K and ion concentration of ~ 10^{16} cm^{-3}. Some experimental details and theoretical relationships are given. [English translation in: Soviet Physics—Doklady (USA), Vol. 5, No. 2, 356-60 (Sept.-Oct., 1960)]. A.G.Gaydon

18841 COLLISIONLESS PLASMA SHOCK WAVES.

H.Yoshihara.

Phys. of Fluids (USA), Vol. 4, No. 11, 1361-5 (Nov., 1961).

A solution for the profile of a collisionless plasma shock wave in the absence of magnetic fields was determined using the nonlinear Vlasov equations. The uniform shock speed is taken to be much less than the electron thermal speed of the ambient plasma. Under these conditions a solution is found for a given Mach number of the shock only for a definite ratio of the electron to positive ion temperatures in the quiescent plasma. Profiles of the macroscopic state variables are calculated for a Mach number of $20^{1/2}$.

18842 HEAT TRANSFER IN A COOLED TUBE IN AN ELECTRIC ARC PLASMA.

W.Springe.

Abhandl. Braunschw. Wiss. Gesell. (Germany), Vol. 12, 135-57 (1960). In German.

Plasma heat transfer problems were investigated by introducing water-cooled calorimetric tubes in stabilized, as well as non-stabilized, electric arc discharges. Plasma temperatures up to 13 000 °K were measured spectroscopically, the heat flux density at the tube surface being between 1×10^6 and 100×10^6 W/m^2. It is shown that with flux densities $> 25 \times 10^6$ W/m^2 the existence of a classical temperature boundary layer is questionable as the boundary layer thickness is of the order of free path dimensions. It is concluded that heat transfer can be explained on the basis of a mass transfer process with reference to enthalpy differences.
I.C.Demetsopoullos

18843 CALCULATION OF THERMODYNAMIC PROPERTIES OF AN ISOTHERMAL HYDROGEN PLASMA.

F.Kümmel.

Beitr. Plasma Physik (Germany), Vol. 1, No. 2, 94-106 (1960-61). In German.

Composition, specific heat, thermal conductivity, electrical conductivity, density, entropy and speed of sound are given for a hydrogen plasma from 10 000° to 50 000°K and 1 to 10 000 torr. A temperature dependent partition function is used, cut off at a maximum quantum number given by the Ecker and Weizel treatment. The lowering of the ionization potential is also taken into account.
C.J.Ultee

18844 THE HIGH FREQUENCY DIELECTRIC PERMEABILITY OF A PLASMA.

V.P.Silin.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 861-70 (Sept., 1961). In Russian.

An expression for the complex dielectric permeability of a totally ionized rarefield plasma is obtained with an accuracy to terms which are square with respect to the number of particles per unit volume. The expression is valid for frequencies which considerably exceed the electron Langmuir frequency. An isotropic plasma as well as a plasma in a magnetic field are considered. In the latter case the variable frequency is assumed to be larger than the Langmuir frequency but it may be larger or smaller than the gyroscopic frequencies of the plasma particles. [English translation in: Soviet Physics—JETP (USA)].

18845 ELECTROSTATIC EFFECTS DURING MOTION OF ATTENUATED PLASMA IN INHOMOGENEOUS MAGNETIC FIELD.

Yu.S.Sigov.

Dokl. Akad. Nauk SSSR, Vol. 138, No. 6, 1337-40 (June 21, 1961) In Russian.

The author considers the electrostatic effects arising from charge separation when an attenuated plasma flows through an i homogeneous magnetic field. A special model of magnetic field adopted and the discussion is limited to the case where the lengt characterizing the inhomogeneity of magnetic field lies between mean free paths and the Larmor radii of the charged particles. is suggested that the electrostatic effects should play an import role in the interaction of streams of conducting gas with the ma field of cosmical objects. [English translation in: Soviet Physi Doklady (USA), Vol. 6, No. 6, 497-9 (Dec., 1961)]. S.P.Ta

18846 VARIATIONAL PRINCIPLES IN PLASMA DYNAMIC

Chau-Hsing Su.

Phys. of Fluids (USA), Vol. 4, No. 11, 1376-8 (Nov., 1961).

A Lagrangian density is constructed for a multifluid system Maxwell's equations and flow equations for inviscid, baratropic, infinitely electrical conducting fluid are obtained from the Lagra gian density through the use of the well-known Lagrange—Euler equations. Flow equations for plasma consisting of electrons an ions are derived from the equations of different species. In this way, in addition to the usual equations of momentum and continui a generalized Ohm's law is also obtained.

18847 FLOW OF LOW-DENSITY HIGH-SPEED PLASMA THROUGH A MAGNETIC BARRIER.

M.A.Gilleo.

Phys. of Fluids (USA), Vol. 4, No. 11, 1399-1406 (Nov., 1961).

The barrier transmission ratio I/I_0 of a stream of plasma can be evaluated from theory in terms of the temperatures and masses of the ions and electrons, the speed of the stream, and th ratio $\Delta B/B_0$ of the height ΔB of the barrier field above the guidi field B_0. All of these parameters were measured for a hydrogen plasma except the ion temperature T_i. Johnson—Malter double-pr data (Abstr. 1078 of 1951) yielded at the maximum density point of t stream a plasma speed of 1.3×10^7 cm sec^{-1}, a number density of 5×10^{13} cm^{-3}, and an electron temperature $\tilde{T}_e = 3.5 \pm 0.2$ eV for $B_0 = 780$ gauss at the position of the barrier. I/I_0 decreased to 0.5 for $\Delta B/B_0 = 17.8$ at which point a theoretical curve was fitted with $\tilde{T}_i = 7.1$ eV; this value for T_i was confirmed by appli tion of the equipartition theory of Spitzer (1956) to the observed change of electron temperature with time.

18848 PLASMA MOTION IN A CURVED MAGNETIC FIELD.

H.P.Eubank and T.D.Wilkerson.

Phys. of Fluids (USA), Vol. 4, No. 11, 1407-11 (Nov., 1961).

A parametric study was made of the transmission of a burst of plasma through a 90° sector of magnetic field. Polarization fields are inhibited during the early phase of plasma entry into th bend, allowing complete transmission of the fast part of the plas (densities ~ 10^{11} cm^{-3}). As the input density exceeds that for wh the polarization field is inhibited, drifts occur which rapidly red the plasma transmission to zero. This transition appears to dep only upon the input density and magnetic field of the bend.

18849 EFFECT OF COULOMB SCATTERING ON TWO-STREAM INSTABILITIES IN A PLASMA.

D.A.Tidm

Phys. of Fluids (USA), Vol. 4, No. 11, 1379-86 (Nov., 1961).

The effect is investigated of a small amount of two-body sca ing on the two-stream instability that occurs in a plasma of cont streaming electrons and ions. This is done by assuming the elec tron—ion collision frequency is small and making a perturbation expansion in this quantiy. The Fokker—Planck scattering formu for the Coulomb interaction is used. It is found that, as the orde streaming energy of the electrons is thermalized, enhanced Land damping competes with the growth of the instability.

18850 BOUNDARY LAYER BETWEEN A PLASMA AND A MAGNETIC FIELD.

H.Grad.

Phys. of Fluids (USA), Vol. 4, No. 11, 1366-75 (Nov., 1961).

The problem of a steady boundary layer or sheath between a plasma and a magnetic field is considered. A self-consistent tra sition layer is found which joins a uniform magnetic field at plus infinity with a collisionless field-free plasma region with arbitra velocity distribution at minus infinity, i.e. a magnetic field profi is found such that the exact particle orbits in this field produce a current which gives rise to the field. An interesting mathematic feature of the "thinnest" such solution is that, with any nonsingul velocity distribution at minus infinity, the magnetic field penetra a finite distance into the plasma although the plasma extends finity, exponentially attenuated, into the magnetic field region. scale of length is the ratio of the speed of light to the plasma iency or, equivalently, the Larmor radius of a representative cle. Electric fields arising from charge separation in the case rticles of different mass are ignored.

851 THE ASSUMPTION OF A SCALAR PRESSURE IN A COLLISIONLESS PLASMA.

Rebut and J.P.Somon.
ma Phys.-Accelerators-Thermonuclear Res. (GB), Vol. 3, , 246-55 (Oct., 1961). In French.

The validity of the assumption is studied assuming the isotropy e velocity distribution functions around a mean velocity. The t solution of the system of equations formed by the collisionless mann's equation and the Maxwell's equations is investigated in isistent non-relativistic approximation. Dynamical solutions found to be impossible. The helical static pinch considered in a ious work is the only case. The magnetohydrodynamical mptions of scalar pressure, state equation, without heat sport lead to the same result.

8852 ELECTROMAGNETIC PROPERTIES OF A RELATIVISTIC PLASMA. II. V.P.Silin.

eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 161-25 (Feb., 1961). ıssian.

For Pt I see Abstr. 19678 of 1960. The reflection and rption are considered of electromagnetic radiation incident endicular to a plane surface bounding an electron plasma with tivistic particle-momentum distribution. The surface impedance e plasma is calculated both for relativistic and nonrelativistic eratures. Specular and diffuse reflection of the electrons from urface of the plasma is investigated. [English translation in: et Physics—JETP (USA), Vol. 13, No. 2, 430-5 (Aug., 1961)].

8853 MAGNETOHYDRODYNAMICS FOR NONISOTHERMAL PLASMA WITHOUT COLLISIONS.

.Klimontovich and V.P.Silin.
eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1213-23 (April, 1961). ussian.

Dissipation due to the absorption of magnetohydrodynamic and neto-acoustic waves by electrons is taken into account. The ltant equations are applied in the analysis of the smearing out packet in the plasma. It is shown that under the conditions med, when the spatial dimensions considerably exceed the ye and Larmor ranges, stationary shock waves with a width h smaller than the mean free path cannot exist. [English slation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 852-8 ., 1961)].

8854 ON THE ANOMALOUS DOPPLER EFFECT IN A PLASMA. M.A.Gintsburg.

eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 752-5 (Sept., 1961). ussian.

Excitation of electromagnetic waves in a plasma by a super- t ion beam is considered by taking into account motion of the in the plasma. The geophysical significance of the problem is cated. [English translation in: Soviet Physics—JETP (USA)].

8855 IMPURITY RADIATION LOSSES FROM A HIGH TEMPERATURE PLASMA. R.F.Post.

sma Phys.-Accelerators-Thermonuclear Res. (GB), Vol. 3, 4, 273-86 (Oct., 1961).

Discusses the general problem of enhanced radiation losses m a hydrogen plasma containing a small percentage, particle- e, of high Z impurities. Because the intrinsic radiation rate per m fron impurities can be many orders of magnitude greater n the Bremsstrahlung radiation from ionized hydrogen, even a all fractional impurity content can greatly increase the total aping radiation flux.

18856 RADIATION FROM A MODULATED ELECTRON BEAM WITH A PLASMA BACKGROUND. P.Parzen.

ppl. Phys. (USA), Vol. 32, No. 11, 2484-8 (Nov., 1961).

Expressions are derived for the electromagnetic radiation from rent-modulated electron beams which emerge from a plasma, h simple formulations in the case where the dielectric constant he plasma is zero or infinity.

18857 THE ABSORPTIVITY SPECTRUM OF A UNIFORM ANISOTROPIC PLASMA SLAB.

I.P.French, G.G.Cloutier and M.P.Bachynski.
Canad. J. Phys., Vol. 39, No. 9, 1273-90 (Sept., 1961).

Using a generalized formulation of Kirchhoff's law it is possible to relate the equilibrium electromagnetic radiation spectrum of a body to its absorptivity spectrum. The microwave absorptivity of a uniform anisotropic plasma slab to a normally incident electromagnetic wave is obtained by matching fields at the boundaries and is solved completely for the model chosen. The absorptivity spectrum of the plasma slab is computed for waves propagating parallel to and normal to an applied static magnetic field for various electron densities, electron collision frequencies, and slab thicknesses. Peaks in the absorptivity spectrum occur around the edges of the "stop-bands". In general the absorptivity increases with slab thickness and collision frequency. The effect of internal reflections is included and gives rise to undulations in the absorptivity spectrum.

18858 INVESTIGATION OF MAGNETOACOUSTIC RESONANCE IN A PLASMA WITH AID OF DOUBLE ELECTRIC PROBES. V.D.Rusanov, B.I.Patrushev, I.A.Kovan, V.I.Garkusha and D.A.Frank-Kamenetskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1497-1502 (Dec., 1960). In Russian.

The concentration of a plasma in a magnetoacoustic wave was measured. It is shown that the ionization increases considerably and rapidly in magnetoacoustic resonance. The radial concentration distribution in the plasma is almost uniform. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1041-4 (June, 1961)].

18859 MAGNETOACOUSTIC RESONANCE IN STRONG MAGNETIC FIELDS.

A.V.Bartov, E.K.Zavoiskii and D.A.Frank-Kamenetskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 588-91 (Aug., 1961). In Russian.

In a plasma in which the magnetic energy is comparable with the electron rest energy (i.e. the electron cyclotron frequency is of the same order as the plasma frequency), the resonance frequency of magnetic sound as a function of the concentration passes through a maximum in a constant magnetic field. Near the peak, the magneto-acoustic resonance can be produced and observed in non-linear conditions (for a varying concentration) and can be employed for ionization of the plasma. [English translation in: Soviet Physics—JETP (USA)].

18860 QUANTUM THEORY OF ACOUSTIC OSCILLATIONS OF AN ELECTRON—ION PLASMA IN A MAGNETIC FIELD.

P.S.Zyryanov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1353-6 (May, 1961). In Russian.

The condition for existence of acoustic excitations is studied using the quantum dispersion equation for electron—ion plasma oscillations. It is shown that in strong magnetic fields longitudinal ultrasonic vibrations,with a wave-vector perpendicular to the magnetic field vector, degenerate into ion vibrations, since in this case the screening radius becomes infinite. The decay frequency of ultrasonic waves moving along the magnetic field as well as across it is calculated. The decay frequency thus determined is found to oscillate depending on the magnetic field strength. [English translation in: Soviet Physics—JETP (USA)].

18861 OBSERVATIONS OF IONIC SOUND WAVES IN PLASMAS. I.Alexeff and R.V.Neidigh.

Phys. Rev. Letters (USA), Vol. 7, No. 6, 223-5 (Sept. 15, 1961).

The waves were observed in cylindrical plasmas with axial magnetic fields of 1 to 7 kG, and in a spherical field-free plasma of radii 2.5 and 25 cm, using signals from a probe in the plasma and from a capacitatively coupled electrode. The frequencies observed (10 to 10^3 kc/s) varied approximately as (ion mass)$^{-1/2}$ and as (dimensions)$^{-1}$, and the harmonic frequencies observed are compared with those calculated assuming a pressure antinode at the walls.

R.S.Pease

18862 ATTENUATION OF [WEAK] MAGNETOHYDRODYNAMIC AND MAGNETOACOUSTIC WAVES IN A PLASMA WITH ANISOTROPIC CONDUCTIVITY AND VISCOSITY. R.V.Doich.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 524-6 (Feb., 1961). In Russian.

The plasma is located in an external magnetic field. The case is considered where the wave frequency is smaller than the particle collision frequency and the wavelength is larger than the mean free path. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 367-8 (Aug., 1961)].

18863 ANISOTROPIC PROPAGATION OF LONGITUDINAL ELECTROACOUSTICAL WAVES IN A DRIFTING PLASMA. V.A.Liperovskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1363-6 (Nov., 1960). In Russian.

The experimentally observed anisotropy in the propagation of low-frequency electroacoustical waves in a low-pressure gas-discharge plasma is explained theoretically within the hydrodynamic approximation by including collisions between charged particles and neutral atoms. From the derived dispersion equation it is found that plane waves of a given frequency will propagate under certain conditions from cathode to anode with an increase in amplitude and from anode to cathode with a decrease in amplitude. This anisotropy is due mainly to the combined effect of charged particle—atom collisions and constant drift motion. In the presence of boundaries the anisotropy is enhanced. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 951-3 (May, 1961)].

18864 INSTABILITY OF LOW-FREQUENCY ELECTROMAGNETIC WAVES IN A PLASMA TRAVERSED BY A BEAM OF CHARGED PARTICLES. M.S.Kovner.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 527-36 (Feb., 1961). In Russian.

The stability of low-frequency longitudinal waves and transverse waves in a magnetoactive plasma traversed by a beam of charged particles is considered. The plasma and beam are both assumed to be uniform and infinite. The plane-wave perturbations are considered that propagate in the direction of the fixed external magnetic field. Stability criteria for the system are derived and the gain factors found for a number of cases. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 369-74 (Aug., 1961)].

18865 TRANSMISSION AND REFLECTION OF ELECTROMAGNETIC WAVES AT A PLASMA BOUNDARY FOR ARBITRARY ANGLES OF INCIDENCE.
K.A.Graf and M.P.Bachynski.
Canad. J. Phys., Vol. 39, No. 11, 1544-62 (Nov., 1961).

The interaction of a plane electromagnetic wave with a flat free-space — plasma interface has been considered for arbitrary angles of incidence. It is shown that the plasma can support independent horizontally and vertically polarized waves. Expressions and graphical representations are given showing the amount of energy entering the plasma as a function of angle of incidence and plasma parameters. The vertically polarized case shows a maximum in the energy entering the plasma at the "Brewster angle". For a lossy plasma, at this maximum, there will be reflection. Loci of constant Brewster angle appear as concentric curves centred on the origin of the complex dielectric coefficient plane. The elliptical polarization of a plane wave reflected from the interface, when a wave with equal horizontally and vertically polarized components is incident on the interface, suggests the similarity of lossless plasmas to ordinary dielectrics and of lossy plasmas to metals.

18866 EFFECT OF AN ELECTRIC FIELD ON WAVE PROPAGATION IN A PLASMA.
P.Bertrand and G.Briffod.
C.R. Acad. Sci. (France), Vol. 253, No. 5, 827-8 (July 31, 1961). In French.

Considers the propagation of electromagnetic and electrostatic waves in a Lorentz plasma in the presence of externally applied electric and magnetic fields with particular reference to the anisotropic distribution of particle velocities. The distribution function used earlier (Abstr. 2776 of 1955) illustrates the coupling found between the two types of wave motion. M.McChesney

18867 ABSORPTION OF ELECTROMAGNETIC WAVES IN A PLASMA. V.I.Perel' and G.M.Eliashberg.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 886-93 (Sept., 1961). In Russian.

The absorption coefficient for electromagnetic waves in a plasma is calculated for $e^2/\hbar v \ll 1$. Application of the temperature diagram technique makes it possible to take into account collective effects in a consistent manner, and to obtain the exact values of t factors in the Coulomb logarithm. [English translation in: Sovi Physics—JETP (USA)].

18868 THE DISPERSION EQUATION FOR AN ORDINARY WAVE MOVING IN A PLASMA PERPENDICULAR T AN EXTERNAL MAGNETIC FIELD.
Yu.N.Dnestrovskii and D.P.Kostomarov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1404-10 (May, 196 In Russian.

A general qualitative investigation is carried out on the dispersion equation for an ordinary e.m. wave moving in a plasm perpendicular to an external magnetic field. The regularities fou are illustrated by some results of numerical solution of the dispersion equation. [English translation in: Soviet Physics—JETP (USA)].

18869 EXPERIMENTS ON THE COMPRESSION OF PLASMA IN CUSP GEOMETRY. T.K.Allen and R.J.Bickerton.
Nature (GB), Vol. 191, 794-5 (Aug. 19, 1961).

Describes an experiment in which a shock preheated plasma was compressed by a rising cusp magnetic field. Plasma electro densities of up to 2×10^{15} cm^{-3} and temperatures up to 5×10^4 ° were produced by the preheating system. When the cusp field was applied instabilities associated with the establishment of an equilibrium state were observed after 2-3 μsec. These were seen using a framing camera and appeared to be Rayleigh—Taylor instabilities. There was evidence of stabilization during the later stages of the compression. Under conditions when the instabilitie did not appear the cusp boundary remained sharp for the first quarter cycle. The density increased by a factor of 10 and the temperature rose to above 2×10^5 °K. J.W.Sturge

18870 MAGNETIC MIRROR CONFINEMENT OF EXPLODIN WIRE PLASMA. E.J.Seykora.
Nature (GB), Vol. 191, 995-6 (Sept. 2, 1961).

A technique is reported whereby the wire to be exploded and coil for the confining magnetic field are connected in series. A capacitor bank of 1.7 μF, charged to 22 kV, was discharged throu this system, producing a current rising in 4 μsec to a peak value about 1.0×10^4 A. This produced a maximum barrier field for the magnetic mirror coil of about 16 kG, and a central field of about 7 kG. Streak photographs are given for the explosion of a 3 mil copper wire, both with and without the containing magnetic field. It appears that the plasma is contained for a time of the order of 0.01 sec when using the mirror system. M.Kas

18871 PLASMA POTENTIAL IN A MAGNETIC MIRROR SYSTEM. D.J.BenDaniel.
Plasma Phys.-Accelerators-Thermonuclear Res. (GB), Vol. 13, No. 4, 235-41 (Oct., 1961).

An estimate is made of the plasma potential created by the more rapid initial loss of electrons from magnetic mirror confinement. The effects of this potential on the mirror ratio of system is discussed. Calculations of this potential as a function position in the magnetic mirror system are presented for two cas of interest.

18872 MAGNETIC-MIRROR CONFINEMENT OF A PLASMA. M.S.Ioffe, R.I.Sobolev, V.G.Tel'kovskii and E.E.Yushmanov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1602-11 (Dec., 1960) In Russian.

The containment of a hydrogen plasma (density 10^9 cm^{-3}) in a cylindrical magnetic-mirror system was studied. The mean io energy in the plasma was 1 — 2 keV, the mean electron energy was approximately 10 eV, and the minimum neutral-gas pressure under operating conditions was $3 - 4 \times 10^{-7}$ mm Hg. Plasma co finement was investigated by measuring the fast-ion lifetime. It was found that ions escape from the confinement system much m rapidly than would be expected on the basis of charge exchange a scattering. Anomalous ion losses were observed only with the plasma in the trap. These losses were not observed when the de of charged particles was reduced to values such that the Debye distance became comparable to the dimensions of the confinemen system. (See also following abstract). [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1117-23 (June, 1961)

873 [ANOMALOUSLY RAPID] LOSS OF PLASMA FROM A MAGNETIC-MIRROR SYSTEM. II.

Ioffe, R.I.Sobolev, V.G.Tel'kovskii and E.E.Yushmanov.
eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 40-8 (Jan., 1961).
ussian.

Investigation of the system described in the preceding abstract. surements of the ionic component of the current to the walls ie system show that the loss is due to the motion of plasma ss the magnetic field lines and that most of the charged icles are lost at the side walls of the system. [English transn in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 27-32 y, 1961)].

8874 PLASMA TURBULENCE IN A MAGNETIC-MIRROR SYSTEM. B.B.Kadomtsev.

eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 328-36 (Jan., 1961).
ussian.

The convective turbulence of a rarefied plasma in a magneticror system is analysed theoretically. The turbulence arises as sult of plasma instability. The results which are obtained are atisfactory agreement with the experimental data of Ioffe et al. lasma lifetime in a system of this kind (see preceding ract). [English translation in: Soviet Physics—JETP (USA), 13, No. 1, 223-8 (July, 1961)].

8875 STABILITY OF PLASMAS AGAINST ELECTROSTATIC PERTURBATIONS. T.K.Fowler.

s. of Fluids (USA), Vol. 4, No. 11, 1393-8 (Nov., 1961).

With the notation $(\partial f/\partial t) + Vf = 0$ for the linearized selfsistent field (Vlasov) equation governing "collisionless" plasmas, shown that, if only the Coulomb force between particles is taken account, a sufficient condition for stability of an equilibrium ribution f (x, v) against small perturbations f is that the linear ator V, a function of f_0, be anti-Hermitian in some representa-. Using this asymmetry requirement, a class of stable functions und, essentially by inspection, which includes spatially confined ributions which might represent a plasma held together by itational forces. Also, some qualitative limits on the nature of able perturbations in thermonuclear "mirror" machines are rmined.

8876 EQUILIBRIUM CONFIGURATION OF THE PLASMA IN THETA DISCHARGES WITH REVERSED TRAPPED GNETIC FIELDS. J.K.Wright, R.D.Medford and B.Chambers.

sma Phys.-Accelerators-Thermonuclear Res. (GB), Vol. 3, 4, 242-5 (Oct., 1961).

The equilibrium state of a long tubular plasma with reversed ped magnetic fields is discussed. It is shown that an equilibrium ition stable to longitudinal perturbations exists for each value of ratio of external to trapped flux providing the cross-sectional a of the plasma is less than half the total area of the system. iations in the containing magnetic field give rise to variations in length and the cross-sectional area of the plasma tube. With ervations confined to the end-view of the plasma and assuming the tube did not vary in length, the observed variation in crosstional area would lead one to an assumption of an apparent value = 4 for the plasma.

18877 STABILITY OF THE HARD-CORE LIQUID MODEL OF THE PINCH. J.N.Tandon and S.P.Talwar.

sma Phys.-Accelerators-Thermonuclear Res. (GB), Vol. 3, 4, 261-5 (Oct., 1961).

A theoretical investigation for the sausage instability of a harde mercury jet is made. It is found that a parallel current system he core and the jet has a destabilizing influence and antiallel current improves the stability of the configuration. a configuration characterized by the same current density he jet and the core, the maximum growth rate is smaller than corresponding growth rate for a homogeneous liquid jet without re.

18878 A NEW "WEDGE" TYPE INSTABILITY OBSERVED IN A "THETA" PINCH.

.Wright, R.D.Medford, J.D.Herbert and R.C.Pottinger.
ure (GB), Vol. 191, 1054-6 (Sept. 9, 1961).

High speed camera shots taken on the first half of the discharge wed bright radial wedges of plasma with less luminous plasma ween. The trapped field was parallel to the driving field. When trapped field was reversed no such effect was observed. It is suggested that the wedges were produced by the growth of Rayleigh—Taylor instabilities under the condition of parallel fields.

J.W.Sturgess

18879 A RELATIVISTIC PINCH-EFFECT. T.T.Vescan.

Nuovo Cimento (Italy), Vol. 21, No. 2, 205-12 (July 16, 1961).
In French.

Studies the relativistic motion of a charge in an electromagnetic field having cylindrical symmetry by deriving the Einstein metric; a generalization of the rotating disk problem. At high velocities, an additional radial force, proportional to 1/r, appears, which may produce pinch effects. H.N.V.Temperley

18880 RAPID COMPRESSION HEATING OF A PLASMA IN THE LINEAR Z-PINCH.

H.A.B.Bodin, A.A.Newton and N.J.Peacock.
Nuclear Fusion (Internat.), Vol. 1, No. 1, 54-61 (Sept., 1960).

The electrical characteristics of discharges with high and low initial rates of current rise are briefly described and the electrical measurements are used to determine the work done on the plasma by rapid compression. The particle and the magnetic energy in the discharge are discussed for both high and low initial rates of current rise (dI/dt (0)) and for discharges with and without an axial magnetic field (H_z). It is shown that the gas is heated much more efficiently both with and without H_z at high dI/dt (0). For dI/dt (0) $\sim 1.5 \times 10^{12}$ amps/sec ($H_z = 0$) 15% of the initial bank energy goes into heating the gas and 10% into the magnetic field at the first maximum contraction; for dI/dt $\sim 10^{11}$ amps/sec ($H_z = 0$) 11% goes into the field and only 6.5% into the gas at this time. The energy input to the gas is found to become limited well before peak current, and the initial implosion is not followed by much of the subsequent isentropic compression heating which might be expected, so that the temperature never exceeds about 300 eV; it follows that most of the observed neutron yield ($\sim 10^9$) is not thermonuclear. Data obtained from the electrical waveforms and from high-speed photographs are presented and analysed, and it is shown that large currents build up outside the central plasma column after the first maximum contraction. Further evidence suggests that these currents flow in wall material boiled off by radiation from the central column. These wall effects account for the absence of further isentropic compression heating and also contaminate the central plasma column; they are such as to prevent any significant gain in heating by increasing the power input to the discharge. It is concluded that similar effects probably account for the failure to achieve a thermonuclear temperature in many high power pinch experiments.

18881 THE DYNAMIC EFFECT OF THE TUBULAR PINCH EFFECT. G.Lehner.

Z. Naturforsch. (Germany), Vol. 16a, No. 6, 546-62 (June, 1961).
In German.

In a tubular pinch configuration the plasma cylinder is simultaneously compressed by magnetic fields radially from the outside as well as from the inside. This configuration was investigated theoretically and experimentally. For the theoretical model ohmic resistivities were neglected and adiabatic compression was assumed. This model yielded the times of the successive compressions of the plasma. For the experiments a capacitor bank of 40 μF and 40 kV was used. It was discharged through a vessel of 50 cm length, 10 cm internal diameter and 20 cm external diameter at 10^{-2} to 10^{-1} mm of deuterium. The maximum currents were approximately 700 kA. The half period was 4.5 μsec. Measurements of currents were made with Rogowski-coils, of magnetic fluxes with loops and of magnetic fields with probes. The time history of the intensity of a number of spectral lines was recorded. The experimental results were compared with the theory, and the experimental times at which compressions occurred were found to be 10% larger than the theoretical times. This discrepancy can be eliminated by the proper choice of a factor in the theory. Two oscillatory modes were evolved from the linearization of the equations of the adiabatic model. These modes resembled the "in" and "out" of phase coupling of two pendulums. Due to the cylinder symmetry of the plasma configuration the "in" phase oscillation was excited. When the amplitude of this oscillation became large enough for the plasma to hit the walls the appearance of spectral lines of impurities from the walls was observed. The intensities of these impurity-lines first decreased and then increased with increasing stabilizing longitudinal magnetic fields. The minimum of the intensities of the lines was found to lie between 500 and

1000 G. The initial decrease of the intensities is interpreted as an increase of the stability of the plasma, while the succeeding increase of intensities is interpreted as a consequence of the "in" phase oscillation.

18882 HYDROMAGNETIC INSTABILITY OF A HOLLOW PINCH EFFECT.

G.Lehner.

Z. Naturforsch. (Germany), Vol. 16a, No. 7, 700-11 (July, 1961). In German.

The method of normal mode analysis of Kruskal and Schwarzschild is applied in an investigation of the instabilities of the tubular pinch. The dispersion formula is derived and discussed for the limits of very large and very small wave numbers k. The cases m = 0 and m = 1 are evaluated numerically. One special case (m = 0, k = 0) is not included in the otherwise general dispersion formula and is therefore discussed separately.

18883 ON THE STABILITY OF PLASMA BUNCHES IN A WAVEGUIDE.

M.L.Levin.

Atomnaya Energiya (USSR), Vol. 8, 134 (1960). In Russian. English translation in: Plasma Phys.—Accelerators—Thermonuclear Res. (GB), Vol. 3, No. 3, 220-1 (July, 1961).

In connection with Veksler's [Atomnaya Energiya (USSR), Vol. 2, 427 (1957)] suggestion for the acceleration of plasma by radiation, the stability was investigated of a uniform ideally-conducting spheroidal plasma in the quasistationary field of a symmetrical H-wave in a circular waveguide. The plasma shape is found to be unstable, and its position on the axis of the waveguide is also unstable. For a symmetrical E-wave there would be focusing onto the axis but at the expense of an electrostatic "swelling" of the plasma. D.M.Gilbey

18884 PLASMA CONFINEMENT IN A TRAP WITH A MAGNETIC FIELD THAT INCREASES TOWARD THE PERIPHERY.

S.Yu.Luk'yanov, I.M.Podgornyi and V.N.Sumarokov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 448-51 (Feb., 1961). In Russian.

The behaviour of a plasma with a density of 10^{13}-10^{14} cm^{-3} in a trap with a magnetic field that increases toward the periphery was investigated. Ultra-high-speed photographs show that plasma instabilities in such traps reduce the containment time. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 308-12 (Aug., 1961)].

18885 STABILITY OF A PLASMA PINCH WITH ANISOTROPIC PARTICLE VELOCITY DISTRIBUTION AND ARBITRARY CURRENT DISTRIBUTION.

V.F.Aleksin and V.I.Yashin.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1115-18 (April, 1961). In Russian.

The necessary conditions for stability of a plasma with an anisotropic distribution of particle velocities located in a helical magnetic field are derived on the basis of kinetic theory without taking short-range collisions into account. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 787-8 (Oct., 1961)].

18886 MAGNETOACOUSTIC OSCILLATIONS AND THE INSTABILITY OF AN INDUCTION PINCH.

A.V.Borodin, P.P.Gavrin, I.A.Kovan, B.I.Patrushev, S.L.Nedoseev, V.D.Rusanov and D.A.Frank-Kamenetskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 317-21 (Aug., 1961). In Russian.

The results of an experimental investigation of the induction pinch are presented. It is shown that the radial oscillations which arise upon rapid compression of the plasma are of a magnetoacoustic nature. Pinch instabilities are also observed in the presence of shock waves of sufficient intensity. [English translation in: Soviet Physics—JETP (USA)].

18887 NECESSARY AND SUFFICIENT CONDITIONS FOR THE HYDROMAGNETIC RAYLEIGH—TAYLOR STABILITY OF A CYLINDRICAL PLASMA.

R.J.Tayler.

Plasma Phys.-Accelerators-Thermonuclear Res. (GB), Vol. 3, No. 4, 266-72 (Oct., 1961).

It is shown that necessary and sufficient conditions for the stability of a cylindrical discharge can be extended to the case in which there is an external gravitational potential present. In particular, explicit forms are obtained for the analogues of three well-known stability criteria: the sufficient condition for stability of the hard-core pinch, Suydam's necessary condition for stability (U.S.A.E.C. LAMS-2381) and the necessary and sufficient conditio for stability against interchange perturbations of a system with a magnetic field of constant pitch.

18888 RAYLEIGH—TAYLOR INSTABILITIES OF A MAGNETICALLY ACCELERATED PLASMA.

T.S.Green and G.B.F.Niblett.

Nuclear Fusion (Internat.), Vol. 1, No. 1, 42-6 (Sept., 1960).

High speed photography was used to study the compression of a deuterium plasma by an axial magnetic field generated by a wid single-turn coil. In this experiment the inductance of the coil is small compared with that of the external condenser bank so that the plasma implodes at a constant acceleration of 5×10^{12} cm/se Flutes which develop on the outer surface of the plasma are interpreted as magnetohydrodynamic Rayleigh—Taylor instabilities produced by the inward acceleration of the interface separating magnetic field and plasma. The observed growth rates are in agreement with simple theory. It is shown that the ratio of the diffusivities of magnetic field and momentum determines whether the plasma resistivity or its viscosity is the dominant mechanism for damping the short wavelength instabilities. At the temperatur and densities of this experiment the resistivity is primarily responsible for the damping and the wavelength of "maximum instability" calculated on this basis agrees with the observed valu

18889 THE POTENTIAL UTILITY OF SCANNING MICROWA BEAMS IN PLASMA DIAGNOSTICS.

R.S.Elliott.

IRE Trans Antennas and Propagation (USA), Vol. AP-9, No. 3, 317-19 (May, 1961).

Four resonances are possible in the interaction between an electromagnetic wave and a plasma in a d.c. magnetic field. One of these, a pole resonance, depends critically on the angle betwee the wave and the magnetic field. It is thus suggested that the data rate in diagnostic experiments could be improved by scanning the plasma by a microwave beam and recording the variation in resonant frequency as a function of scan angle (time). The techni will clearly be of interest in cases where time varying plasmas are under investigation. G.D.Si

18890 RECOMBINATION RADIATION OF A CAESIUM PLAS IN A HOMOGENEOUS MAGNETIC FIELD.

Yu.M.Aleskovskii and V.L.Granovskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 363-7 (Aug., 196 In Russian.

The recombination radiation from a caesium vapour plasma induced by a longitudinal magnetic field was investigated spectrophotometrically. It is found that recombination emission apprecia increases with the growth of the field strength and the decrease o the gas pressure. This increase is mainly due to the increase in concentration of the charge carriers near the column axis and, to smaller degree, to the decrease of the electron temperature. [English translation in: Soviet Physics—JETP (USA)].

18891 THE HIGH-ENERGY ELECTROSTATIC PLASMA GUN.

R.Fox.

Plasma Acceleration Symposium,Palo Alto, Dec., 1959 (see Abstr 10694 of 1961) p. 94-117.

A theoretical study of a high-energy plasma gas where ions are accelerated electrostatically and then neutralized by thermon ically produced electrons. A plasma velocity of 8.5×10^{6} cm/sec is assumed. Consideration is given to the effect of space charge on beam spreading and ion beam trajectories are plotted for vario fractions of space-charge-limited ion current. The electron sour must be located with great care to avoid the electrons entering th ion source; an auxiliary electrode suitably biased prevents this. Voltage and current densities are computed for an ion source consisting of porous tungsten in conjunction with a caesium surfac ionizer. The effect of low energy ions in the beam produced by charge exchange and impact ionization is considered and provisio made for their removal. There is a brief review of available ion sources, a discussion of the caesium-surface ionizer and the effe of sputtering on gun performance. M.McChesn

18892 PLASMA ACCUMULATION IN A DEVICE FED BY ENERGETIC-ION TRAPPING.

R.J.Mackin, Jr.

Nuclear Fusion (Internat.), Vol. 1, No. 2, 131-8 (March, 1961).

Plasma accumulation (without energy losses) in a device in which energetic ions are injected and trapped has been discussed by Simon (Abstr. 9613 of 1961). Simon presented a general stead

theory for devices, such as the OGRA device, where trapping
itiated by interactions with background gas. For such devices
is usually a critical input current or critical plasma density
nction of input current) above which plasma density builds up
value limited by Coulomb scattering losses. For a specific
me of operation (600 keV hydrogen molecular ion injection
dissociation, highly efficient ion-pumping action of the trapped
ma), simple approximate formulae are derived which describe
ritical current or density for plasma build-up. Second-
oximation formulae are derived which describe with about
error the overlapping segments of the density versus current
e for a broad range of parameters. The analysis is applied to
stem in which the initial trapping is accomplished by a Luce
on arc, e.g. DCX-2. Two new aspects emerge: (1) if the arc
rned off slowly or if an arc of lower density is used, then the
cal current for plasma build-up with arc is nearly an order
agnitude less than previously estimated; and (2) the critical
density, below which plasma build-up occurs after the arc is
oved, is sufficiently low that energy losses to fixed-temperature
electrons are not significant. The time-dependence of plasma
l-up, certain aspects of the impurity problem, and electron
ng effects are also considered. Numerical examples are
for OGRA and DCX-2.

893 DETERMINATION OF THE CHARACTERISTICS OF A PLASMA JET EMERGING IN THE FREE ATMOSPHERE.
umann.
. Plasma Physik (Germany), Vol. 1, No. 2, 119-25 (1960-61).
rman.
The energy content of an argon plasma jet is determined as a
ion of electrical power input and gas flow. Plasma volume,
tive and maximum plasma "temperatures" and radiation losses
also tabulated. C.J.Utlee

sma Oscillations

894 PLASMA OSCILLATIONS (I).
I.B.Bernstein and S.K.Trehan.
ar Fusion (Internat.), Vol. 1, No. 1, 3-41 (Sept., 1960).
This is a review of the theory of wave phenomena in plasmas.
asic kinetic theory is developed taking into account Coulomb
sions. From this magnetohydrodynamic equations are derived.
demonstrated that it is legitimate to deal with a closed subset
ese equations either in the limit of collision-dominated
omena, or in the limit where the effective phase velocities of
henomena of interest are much greater than thermal speeds.
se of collision-dominated plasmas the theory of transport
icients is discussed. These equations are then applied to an
sive treatment of small amplitude wave phenomena in plasmas.
cussion of the dissipative effects on hydromagnetic waves is
. Hydromagnetic waves are also considered from the Chew,
berger and Low theory. Longitudinal and transverse oscillations
rrent-carrying plasmas are also discussed. Oscillations of
indrical plasma are considered and the phenomenon of ion
tron resonance is discussed. The possibility of radiation by
na oscillations by a uniform sphere is exhibited. Some
al results on the stability of longitudinal electron oscillations
n-uniform plasmas are given. A brief treatment of large
itude electron oscillations is given and the breaking of these
lations as a dissipative mechanism for the organized plasma
on is discussed.

895 PLASMA OSCILLATIONS AND DYNAMICAL FRICTION. A.Hruška.
h. J. Phys., Vol. 11, No. 4, 268-71 (1961).
The force F of mutual interaction of two species of charged
cles in relative motion with velocity U is, for U higher than
nean thermal velocities of particles, a decreasing function of
his property of F(U) can give rise to the excitation of
rostatic oscillations.

896 OSCILLATIONS IN A PLASMA IN A WEAK MAGNETIC FIELD. S.Kojima, E.Kawasaki and K.Kato.
ys. Soc. Japan, Vol. 16, No. 7, 1487-8 (July, 1961).
Oscillations were observed in a bounded plasma in a weak
nal magnetic field. The oscillations occurred when either the
arge tube had a cathode of good electron emission or the
sure of the tube was sufficiently low. M.Hasan

18897 PLASMA OSCILLATIONS IN EXTERNAL FIELDS.
M.Sumi.
J. Phys. Soc. Japan, Vol. 16, No. 9, 1718-28 (Sept., 1961).

Plasma oscillations are considered under uniformly applied electric and magnetic fields. When the external field is so weak that the particle runaway is not yet appreciable and the drift motion between electrons and ions is regarded as quasi-stationary compared with the oscillation frequency and particle gyrations, the usual Laplace transform method can be approximately employed. The dispersion relation thus obtained describes the excitation of ion waves. The behaviour of these waves is discussed, their temporal developments being taken into account.

18898 EXPLORATION OF OSCILLATING BEAM-PLASMA FIELDS WITH A TRANSVERSE ELECTRON BEAM.
A.Garscadden and K.G.Emeleus.
J. Electronics and Control (GB), Vol. 9, No. 6, 473-6 (Dec., 1960).

Some experiments are described in which a low-pressure oscillating electron-beam and plasma system is explored by a second electron beam transverse to the first. The energy spread (scattering) found in the main system when high frequency, probably electrostatic oscillations are occurring, is found to be present in the exploring beam only when the latter is in or has traversed a section of the main discharge where oscillations and scattering can be detected. With the discharge described, the magnitude of the scattering in the transverse beam was about 6 V when the scattering in the main beam was about 14 V. The results appear to be compatible with considerable randomization and possible break-up of the main beam by the oscillations.

18899 NONLINEAR OSCILLATIONS OF RARIFIED PLASMA. I.
A.A.Vedenov, E.P.Velikhov and R.Z.Sagdeev.
Nuclear Fusion (Internat.), Vol. 1, No. 2, 82-100 (March, 1961).
In Russian.

The paper basically is a review of a number of studies devoted to the theory of nonlinear motions of plasma under conditions where collisions between particles do not play a determining role. The problem concerns the evolution in time of an initial perturbation of finite amplitude. The resulting physical picture will depend on these competing processes: nonlinear increase of wave steepness, dispersion, absorption and instability. In a number of cases where adsorption and instability are insignificant, it is possible to obtain an idea of the character of the nonlinear motions by applying the appropiate linear "dispersion law". Certain specific types of non-stationary nonlinear motions are dealt with which permit exact mathematical solution, namely: nonlinear oscillations of electrons at zero temperature, nonlinear motion of plasma across a strong magnetic field, and ion waves of finite amplitude in non-isothermal plasma where $p_i \ll p_e$. In a number of instances, evolution of the initial perturbation leadsto the formation of a multi-component current, some pecularities of which are discussed. Stationary non-linear waves are described, i.e. waves not changing their form with time. In a particular case they are the so-called "solitary waves", similar to waves on the surface of heavy liquid in a channel of finite depth. The possibility of the existence of such waves requires linear laws of dispersion of a specific character. The possibility of "solitary" waves of rarefaction is pointed out. The question of absorption of waves in rarified plasma is discussed. An approximate "quasi-linear" method is developed which permits the kinetic considerations in the absorption of waves of finite amplitude to be simplified. The method consists in the representation of the distribution function f(r, v, t) as a sum of rapidly and slowly varying terms. In the equation for the slowly varying term a quadratic average effect of fast oscillations is taken into consideration. This method is applied to two particular problems: the absorption of Langmuir electronic oscillations (in the limit of very small amplitude the equation for wave-damping goes over into the well-known formula for the so-called "Landau-damping"), and the cyclotronic absorption of transversely polarized waves which propagate along the constant magnetic field. In the last section some types of instabilities of non-linear motions are shown. In addition to the instabilities associated with the multi-component motion, it is shown that waves in a magnetic field (in particular, solitary waves) are unstable if their amplitude exceeds a certain critical value which decreases as the plasma temperature decreases.

18900 FLUCTUATIONS OF A PLASMA. I.
N.Rostoker.
Nuclear Fusion (Internat.), Vol. 1, No. 2, 101-20 (March, 1961).

A fully ionized plasma is considered.. A time t the state of the system is represented by a point X in the phase space of all the particles. $D_s dX dX' \ldots dX^{(s)}$ is defined as the joint probability that at time t the system will be in (X, dX), at time t' in (X', dX'), etc. A systematic procedure was developed for calculating any desired moment of D_s as an expansion in the discreteness parameters e, m, and 1/n. Spectral densities and autocorrelation functions can thus be obtained without any "Stosszahlansatz" or Markoffian assumption. A comprehensive treatment of a plasma in thermal equilibrium was carried out. A large class of non-equilibrium states may exist in a hot plasma for sufficient time to be considered stationary. Fluctuations were calculated for the class of spatially homogeneous states of an infinite plasma. It is of some interest that thermal equilibrium relationships such as Kirchhoff's radiation law and the fluctuation-dissipation theorem survive. As an application the degree of excitation of the collective modes such as plasma waves, ion oscillations, etc. were calculated. For distribution functions which approach instability as some parameter is varied, the energy for some modes becomes very large and ultimately becomes infinite as instability is approached.

18901 DAMPING OF PLASMA OSCILLATIONS IN THE LINEAR THEORY. J.N.Hayes.

Phys. of Fluids (USA), Vol. 4, No. 11, 1387-92 (Nov., 1961).

The problem of stable oscillations of an infinite plasma is re-examined from the standpoint of an integral equation for the electric potential in the plasma. The behaviour of a plasma with a Lorentz distribution is solved completely. It is shown how one may compute, under suitable restriction, the initial velocity distribution when the electric potential has been specified for all time. Then the problem is solved for an initial velocity distribution which yields an electric potential which is non-oscillatory in character and damps as a Gaussian distribution in time; the initial velocity distribution is proved to be an entire function in velocity space. Since this result is contrary to that of Landau, his method of determining the electric potential is re-examined.

18902 UNSTABLE CYCLOTRON OSCILLATIONS IN A CYLINDRICAL PLASMA SHELL.

P.Burt and E.G.Harris.

Phys. of Fluids (USA), Vol. 4, No. 11, 1412-16 (Nov., 1961).

Longitudinal oscillations of a finite, cylindrical shell of plasma in uniform axial magnetic field were investigated. The ions are assumed to move initially in concentric Larmor orbits while the electrons are stationary. By neglecting random velocities, it is possible to obtain a dispersion relation for longitudinal (electrostatic) waves which is solved in the limit of short-wavelength perturbations. The real parts of the frequencies of the disturbances are found to be integral multiples of the ion cyclotron frequency. Conditions for instability similar to those of the infinite plasma are also found which depend upon the thickness of the shell.

18903 QUANTUM THEORY OF THE SPECTRUM OF EXCITATIONS OF AN ELECTRON GAS IN A MAGNETIC FIELD.

P.S.Zȳryanov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1065-71 (April, 1961).
In Russian.

The quantum dispersion equation is found for the longitudinal oscillations of an electron gas in a magnetic field, for the case of an arbitrary energy distribution of the particles. A criterion (with respect to the magnetic field) for the applicability of the hydrodynamical approximation is established. It is shown that as one goes from very high magnetic field strengths to low fields the frequency of the longitudinal oscillations changes discontinuously. The longitudinal permittivity of a plasma is calculated. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 751-5 (Oct., 1961)].

18904 ENERGY ABSORPTION IN A LONGITUDINAL WAVE IN A COLLISIONLESS, MAGNETIZED PLASMA.

A.Kildal.

Plasma Phys.-Accelerators-Thermonuclear Res. (GB), Vol. 3, No. 4, 256-60 (Oct., 1961).

Calculates the energy absorption in a longitudinal plasma wave. The direction of propagation is arbitrary with respect to an external magnetic field H_0. Electrons experiencing a constant electric field are responsible for the absorption. In the non-magnetic case these electrons have a velocity equal to the wave's phase velocity. On the assumption that the absorbed energy is extracted from the wave-field, a damping factor is calculated. When this factor is evaluated for the same cases as studied previously by other authors, complete agreement is found. This damping is called "Landau damping."

18905 GYROTROPIC PROPERTIES OF A PLASMA IN PROPAGATION OF THE EXTRAORDINARY WAVE.

B.I.Patrushev, V.D.Rusanov, I.A.Kovan, V.V.Savichev and D.A.Frank-Kamenetskiĭ.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1503-7 (Dec., 1960)
In Russian.

Rotation of the propagation and polarization vectors was observed experimentally in a plasma for propagation of an electr magnetic wave at a frequency between the ion and electron cyclot frequencies. [English translation in: Soviet Physics—JETP (US Vol. 12, No. 6, 1045-8 (June, 1961)].

18906 CONTRIBUTION TO THE THEORY OF PLASMA FLUCTUATIONS.

A.I.Akhiezer, I.A.Akhiezer and A.G.Sitenko.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 644-54 (Aug., 19
In Russian.

The spectral distributions and correlation functions are derived for various fluctuating quantities (electron and ion densitie electron and ion current densities, electric and magnetic fields, particle distribution functions). The possible difference between the electron and ion temperatures is taken into account. The cro sections for scattering of electromagnetic waves on plasma flucti tions are determined. It is shown that the possibility of propagat of Langmuir oscillations as well as high frequency sound waves (a nonisothermic plasma) leads to the appearance of satellites in t spectrum of the scattered radiation. In the presence of a constar magnetic field, satellites appear in the scattered radiation spectr which are due to the possibility of propagation of Langmuir, Alfv and magnetoacoustic waves in the plasma. [English translation i Soviet Physics—JETP (USA)].

18907 CONTRIBUTION TO THE THEORY OF ELECTROMAGNETIC FLUCTUATIONS IN A PLASMA.

V.P.Silin.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 969-76 (Sept., 19
In Russian.

Fluctuations in a nonequilibrium plasma are considered in th case of absence and presence of strong magnetic fields. [English translation in: Soviet Physics—JETP (USA)].

ELECTRON EMISSION
ELECTRON BEAMS

18908 FIELD EMISSION FROM SILICON AND GERMANIUM FIELD DESORPTION AND SURFACE MIGRATION.

F.G.Allen.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 87-99 (April, 1961)

Field desorption has been used successfully to produce clear germanium patterns in the electron field emission microscope. field-cleaned pattern transforms upon annealing to one very simi to that obtained from silicon cleaned by heating in vacuum. Changes in impurity concentration at the surface during cleaning avoided by the desorption technique. Surface atom mobility becomes appreciable at ~250°C on clean germanium and at ~800 on clean silicon. Field emission current—voltage characteristic for both clean Ge and Si are presented. The results are discusse in the light of existing theory, and the need for a theory including emission from surface states and the valence band is pointed out.

FIELD EMISSION FROM SILICON. See Abstr. 17650

ON THE THEORY OF FIELD EMISSION FROM SEMICONDUCTORS. See Abstr. 17649

18909 TEMPERATURE DEPENDENCE OF ELECTRON EMISSION IN THE FIELD EMISSION REGION.

R.Klein and L.B.Leder.

Phys. Rev. (USA), Vol. 124, No. 4, 46-9 (Nov. 15, 1961).

The variation in field emission current as a function of the temperature of the emitter was measured for tungsten over the range from 4.2° to 400°K. The expected form of the temperature dependence of the emission current confirms the relationship previously postulated on theoretical grounds (Abstr. 5915 of 1956 is $j(T) = j(0)(KT/\sin KT)$, where K is a constant depending on vork function and the field at the surface of the emitter. A ent-increment method, in which the increase of current is ed against the square of the temperature increase at constant , gives a straight line whose slope permits surface field ulations more precise than heretofore possible by electron oscope measurement of tip radius.

910 FIELD EMISSION FROM NIOBIUM IN THE NORMAL AND SUPERCONDUCTING STATES.

ein and L.B.Leder.

. Rev. (USA), Vol. 124, No. 4, 1050-2 (Nov. 15, 1961).

The change of field emission current from a superconductor result of a transition to the normal state under constant field emperature conditions is calculated. The derivation is based e Bardeen—Cooper—Schrieffer formulation of the density of s and band gas model for a superconductor. The experimental od for determining the current change consisted in measuring urrent increment between a niobium field emitter in the rconducting state at 4.2°K and in the normal state at a tempera- T above the transition. After correcting for the current ase occurring as a result of the temperature increase alone, esidual would be that associated with the superconducting— al transition. This was less than the detectability of the surements, although the calculations indicated an expected ase in current easily measurable of the superconducting— al transition had occurred at the emitter surface. It is ulated that under high-field conditions, the superconducting is quenched at the surface.

911 THE INFLUENCE OF CHOICE OF THE ALKALINE EARTH METAL CARBONATES ON THE EMISSION PERTIES OF OXIDE-COATED CATHODES. S.Firkowicz.

Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 5, 39-43).

A statistical analysis of emission data obtained from cathodes ed with the mixed oxide (Ba,Sr)O suggests that the emission ent is greater the smaller the carbonate crystals from which xide is prepared, and also that needle-like crystals of the onate lead to an oxide with a greater emission than sphere-like onate crystals. It is further confirmed that the mixed oxide Sr,Ca)O provides much stronger emission than does (Ba,Sr)O. homogeneity of the emission current is greater the more the of the carbonate crystals resembles a sphere. C.H.B.Mee

912 DEPENDENCE ON POLARIZATION OF THE PHOTOEMISSION FROM COMPOUND CATHODES THE ANOMALOUS VECTOR EFFECT WITH CAESIUM- IMONY. H.Hora.

er Jahrbuch (Germany), 1960 II, 514-610. In German

The action of the photocathodes is discussed in detail and the rption constants and edges are determined for Cs_2O and materials. The sensitivity of the cathodes, in terms of ive outputs, is measured as a function of the wavelength and of incidence of the light. There is found to be a wall structure pical cathodes and this gives rise to anomalous variations in itivity as the angle of incidence and degree of polarization of ight are varied. C.A.Hogarth

913 EFFECT OF ULTRA-VIOLET IRRADIATION ON THE ELECTRICAL CONDUCTIVITY OF CATHODES TED WITH BARIUM OXIDE. C.H.B.Mee.

re (GB), Vol. 191, 1383-4 (Sept. 30, 1961).

The dark electrical conductance σ of BaO-coated cathodes was sured as a function of the absolute temperature T before and u.v. irradiation. Significant differences were found in the form e curves of log σ versus 1/T thus obtained. Irradiation eased the value of σ at room temperature, and this enhancement maintained while the cathode was heated to about 550°K. Above temperature, and on cooling the cathode, conductance values the same as before irradiation. The effect is discussed in s of the occupation of vacant donor levels just below the uction band by excitation from the filled band during irradiation, by the subsequent transition of electrons from these levels to onduction band as the sample is heated. C.H.B.Mee

914 EXOELECTRONIC EMISSION OF COLOURED CRYSTALS. O.D.Knab.

tverdogo Tela (USSR), Vol. 3, No. 8, 2293-7 (Aug., 1961). ssian.

Results are given of the thermionic exoelectronic emission, thermoluminescence and the temperature dependence of the conductivity of X-ray coloured quartz. Some maxima of the emission are mainly due to processes connected with the ionization of trapping centres distributed throughout the volume, but there are many surface and sub-surface traps which are filled with electrons. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

18915 ELECTRON EMISSION FROM QUININE SULPHATE AND DICKITE. G.Kanzler.

Z. Phys. (Germany), Vol. 164, No. 1, 126-8 (1961). In German.

Describes a study of electron emission from quinine sulphate and dickite ($Al_4.(OH)_8/ Si_4O_{10}$) in the temperature range -100° to 300°C in air and in vacuo. C.G.Morgan

18916 A NEW THERMIONIC GENERATOR. D.Gabor.

Nature (GB), Vol. 189, 868-72 (March 18, 1961).

A device for the direct conversion of heat to electricity via thermionic emission, in which the electronic space charge is compensated by the supply of ions from an auxiliary discharge in argon or an argon-mercury mixture, is described. The main discharge takes place between a heated emitter and a cellular collector, and the auxiliary discharge between a gauze mounted perpendicular to the pores of this collector and an auxiliary anode. The voltage drops in the discharges are such that no excitation occurs in the main discharge, but some electrons from the main discharge pass through the gauze, causing ionization; the ions which return through the gauze from the auxiliary region serve to prevent space-charge limitation of the main discharge current. The experimental results generally confirm the theory of space-charge compensation due to Langmuir (Abstr. 3629 of 1929). It is suggested that efficiencies as high as 30% and power densities of up to 6 kW/ft^2 may be attained with presently available cathode materials. Technical problems relating to the selection of suitable cathode and collector materials, and of a material for the envelope of the generator, are discussed. C.H.B.Mee

18917 THERMIONIC AND INDUCED PHOTOELECTRON EMISSION IN ZINC SULPHIDE. W.Behmenburg.

Z. Phys. (Germany), Vol. 164, No. 2, 222-8 (1961). In German.

Thermionic emission (TE), thermoluminescence (TL), and induced photoelectron emission (IPE) of ZnS were investigated after electron bombardment. Unlike other substances, TE and TL in ZnS have different origins; TL is caused by traps within the forbidden energy gap in the interior of the crystal, while a sorption layer on the crystal surface is responsible for TE. IPE is caused by a third mechanism.

18918 PHENOMENOLOGICAL TREATMENT OF THE PHOTON-ELECTRON INTERACTION IN A PLASMA.

H.Hora and H.Müller.

Z. Phys. (Germany), Vol. 164, No. 4, 359-66 (1961). In German.

Discusses the existence of a simple physical connection between the Richardson equation for thermionic emission and the Richardson equation for photoelectric emission. It is supposed that electrons are not only elements of a (Fermi—Dirac) statistical ensemble, and as such cause thermionic phenomena, but they can also interact with a radiation field, thereby causing an additional emission current according to the Richardson (photoelectric) equation. It is shown in detail that the current emitted from a metal of 2000°K is only determined by the complete radiation of this metal to a very slight degree. It is estimated, however, that at temperatures of some millions of degrees Kelvin the electron excitation caused by complete radiation will be much greater than that caused by interaction.

18919 THE EFFECTS OF GAMMA RADIATION ON SOLIDS. EXO-ELECTRON EMISSION FROM IRRADIATED IRON OXIDE CATALYSTS. E.J.Gibson.

J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 220-8 (Jan., 1961).

The results are presented of an exploratory study into the emission of exo-electrons from powdered iron oxide catalysts for the Fischer—Tropsch synthesis after exposure to gamma radiation. It is considered that the evidence supports the theory that emission centres consist of oxygen ion vacancies containing trapped electrons. The role of irradiation appears to be the filling of the vacancies with electrons.

18920 **ON THE PROBLEM OF EXO-ELECTRON EMISSION FROM POWDERED SINGLE CRYSTALS OF KCl, PREVIOUSLY COLOURED BY VARIOUS METHODS.**
B.Sujak and A.Szaynok.
Acta phys. Polon. (Poland), Vol. 20, No. 5-6, 425-32 (1961).
In German.

Exo-electron glow curves and curves of photoelectric emission as a function of time were obtained from crushed samples of coloured KCl crystals. The form of the curves depended strongly on the method of colouration. Samples from crystals coloured by heating in potassium vapour (a) showed peaks in the glow curves at about 260°C and 380°C; samples from crystals coloured by X-irradiation or by electron bombardment (b) showed little structure in the glow curves, and only a very small emission below 350°C. (a)-samples showed little decay of photoemission with time, while (b)-samples showed a very strong decay. C.H.B.Mee

18921 **PHOTOELECTRIC EMISSION: EFFECT OF SURFACE AND VOLUME.** P.Vernier.
J. Phys. Radium (France), Vol. 22, No. 7, 463-4 (July, 1961).
In French.

A short note which examines theoretically the influence of the polarization of light on photoelectric emission and its use in examining the origin of photoelectrons. C.G.Morgan

PHOTOELECTRON EMISSION OF AMORPHOUS AND CRYSTALLINE FILMS OF GERMANIUM. See Abstr. 17872

18922 **THE ANALYSIS OF SPECTRAL YIELD AND ACCELERATING FIELD CHARACTERISTICS OF THE PHOTOELECTRIC EMISSION FROM SEMICONDUCTORS.**
D.Haneman and E.W.J.Mitchell.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 82-5 (Aug., 1960).

The relation between yield and accelerating field characteristics of the photoelectric emission from semiconductors is discussed. A comparison of the photoelectric thresholds deduced from these two characteristics is made for germanium, gallium arsenide and indium antimonide.

18923 **SEMICONDUCTORS YIELD IMPROVED ELECTRON MULTIPLIER.**
F.A.White, J.C.Sheffield and W.D.Davis.
Nucleonics (USA), Vol. 19, No. 8, 58-60 (Aug., 1961).

Two slabs of n-type gold-doped silicon form parallel-plate dynodes of effective length 2 cm spaced 1·5 mm apart. Perpendicular magnetic and electric fields cause secondary electrons to move in cycloidal trajectories in the space between the plates. The semiconductor is cooled to -50°C to increase its resistance to 10^7 ohm cm. A gain of 10^6 and counting rates greater than 10^6 pulses/sec with short rise-times are possible. The multiplier is particularly suitable for use as a detector in mass spectrometers since its small size allows two adjacent detectors to collect ions from isotopes differing by only one mass unit. Possible future developments include a directional detector built up of a number of semiconducting plates, and an image intensifier. R.D.Smith

18924 **ON THE PROBLEM OF SECONDARY ELECTRON AND INDUCED PHOTOEMISSION FROM GERMANIUM AND SILICON.** G.Kanzler.
Z. Phys. (Germany), Vol. 164, No. 1, 120-5 (1961). In German.

The electron emission from germanium occurring under irradiation with long wavelength light was studied after electron stimulation. The relationship between thermal and induced photoemission for silicon was studied. A.J.Fox

18925 **THE DETERMINATION OF THE RANGE OF SLOW TRULY SECONDARY ELECTRONS.**
I.M.Bronshtein and B.S.Freiman.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1371-2 (May, 1961).
In Russian.

The range of secondary electrons in a particular metal A may be deduced from a knowledge of the electron emission from a layer of metal A placed on top of a layer of some other metal B. This holds true even when B is an oxidized version of A. The secondary electron range in Ba, Ca, and Be, is by this means shown to be about 10 atomic layers. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 995-6 (Nov., 1961)].
A.E.I. Research Laboratory

18926 **THE ROLE OF REFLECTED ELECTRONS IN SECONDARY ELECTRON EMISSION.** M.V.Gomoyu
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2319-21 (Aug., 1961).
In Russian.

See Bronstein et al. (Abstr. 7146-7 of 1960). Discusses the
effect of the change in the energy spectrum of the reflected
electrons as the film thickness increases and points out an erro
work by Bronstein et al. [English translation in: Soviet Physic
Solid State (USA)]. R.Be

**AVERAGE KINETIC ENERGY OF DIFFUSING PARTICLES
ELECTRON TUBES.** See Abstr. 18816

18927 **A UNIFIED THEORY OF ELECTRON BEAM INTER
ACTION WITH SLOW WAVE STRUCTURES, WITH
APPLICATION TO CUT-OFF CONDITIONS.** R.M.Bevensee.
J. Electronics and Control (GB), Vol. 9, No. 6, 401-37 (Dec., 19

A new analysis of slow wave structures coupled to electron
beams is presented which is based on their resonant properties
rather than their travelling wave properties. Thus the analysis
particularly appropriate for narrow band slow wave structures.
The fields of a general symmetrical cavity chain are expanded
in a set of solenoidal and irrotational short-circuit modes,
defined within electric shorting planes on the coupling surfaces.
The amplitudes of the modes are evaluated in terms of the bea
current and tangential electric field on the coupling surfaces.
The latter field is expanded in a set of open-circuit modes whic
amplitudes are related back to those of the short-circuit modes
with the aid of a Variational Principle. Alternately the fields o
cavity are expanded in a set of open-circuit modes, "driven" by
beam current and by tangential magnetic field on the coupling
surfaces. This later field is then expanded in a set of short-circuit modes, which amplitudes are related to the open-circuit
mode amplitudes with the aid of the Variational Principle. The
accuracy of this procedure is verified for a narrow pass-band
proving the relation power flow equals stored energy times gro
velocity. It is possible to prove the equivalence of the dispersi
relations for a "cold" structure obtained from the short- and fr
the open-circuit mode expansions. The small signal transmiss
line equations are then obtained for a longitudinally confined
beam, including relativistic effects, under the action of cavity
solenoidal electric field and space charge irrotational field. T
analysis is applied to a study of the beam-circuit interaction w
the slow space charge beam mode is nearly synchronous with t
"cold" circuit near the latter's cut-off. This is the situation w
often leads to oscillations in high-power structures, interfering
with their operation at a lower frequency. On a small-signal b
four waves exist, two of constant amplitude and a pair of growi
and decaying waves. The cut-off oscillations, which exist in a
relatively wide voltage range such that the slow beam mode is
synchronism with the "cold" circuit near the cut-off are attributed to the presence of the growing wave of forward circuit
power and negative beam power. As the voltage is lowered (in
structure of forward group velocity from zero to π phase shift),
the negative power of the growing wave changes to positive pow
at about the condition marking the boundary of the cut-off oscill
ations. As the voltage is lowered further, two constant amplitu
waves of negative beam power appear, enabling backward wave
oscillations to exist within a narrow voltage range. This distinction between cut-off oscillations and backward wave oscillations should be made in the general class of slow wave structures.

**PRODUCTION OF MAGNETIC FIELDS USED FOR STRONG
FOCUSING BY MEANS OF IRON-FREE COILS.**
See Abstr. 18941

18928 **DISTORTION AND RESOLUTION OF DIFFRACTION
PATTERNS OBTAINED BY LE POOLE'S
TECHNIQUE.** W.D.Riecke.
Optik (Germany), Vol. 18, No. 8, 373-401 (Aug., 1961). In Germ

In Le Poole's selected area microdiffraction technique, the
electron diffraction pattern is imaged by magnetic electron lens
Aberrations in these lenses cause distortion of the diffraction
pattern as well as a decrease in the diffraction resolution. The
magnitude of these errors is calculated by regarding the imagin
lenses as thin lenses. It is thus found that in practice the diffra
tion resolution is limited by the resolution of the photographic
plate rather than by lens aberrations. Some of the calculated

lts are compared with experimental values, and the agreement
itisfactory. If the calculated errors are compared with the
lts of a more rigorous treatment, it appears that the use of the
lens model provides an adequate approximation for these
oses.

8929 PROPOSED USE OF MAGNETIC FIELDS IN ELECTRON MICROSCOPIC RADIOAUTOGRAPHY. L.G.Caro.
re (GB), Vol. 191, 1188-9 (Sept. 16, 1961).
Simple calculations show that a magnetic field of the order of
3 is required to give sufficient curvature to β-ray tracks and
ence electron microscope radio-autographs. J.R.Mallard

8930 RESOLVING POWER OF A SPHERICALLY CORRECTED ELECTROSTATIC ELECTRON
ROSCOPE. W.E.Meyer.
k (Germany), Vol. 18, No. 2, 69-91 (1961). In German.
The theoretical resolution limit is calculated. General
ulae for the aberrations due to misalignments, which affect
quality of the central part of the image, are developed to the
l order. Methods and devices for controlling such aberrations
discussed. By means of a proposed process of alignment a
lution limit of about 4 A should be attainable with a microscope
king at 40 kV.

8931 PRACTICAL RESOLVING POWER OF ELECTRON MICROSCOPES. W.E.Meyer.
k (Germany), Vol. 18, No. 3, 101-14 (1961). In German.
The resolving power is often not only impaired by misalign-
ts but also movement of the image during exposure. A survey
e many possible causes of such movement is given, and the
t important are discussed with regard both to their order of
nitude and to possible means of avoiding them.

8932 THE EXACTNESS OF AGREEMENT BETWEEN SELECTED AND DIFFRACTING AREAS IN LE POOLE'S
ECTED-AREA DIFFRACTION TECHNIQUE. W.D.Riecke.
(Germany), Vol. 18, No. 6, 278-93 (June, 1961). In German.
It is shown by theoretical consideration and experiment that
iffraction pattern, obtained in the three-stage electron micro-
using Le Poole's selected-area diffraction technique, does
correspond exactly to the specimen area selected within the
ht-field image. In the selector-aperture plane, spherical
ration and incorrect focusing of the objective lens give rise to
ift of the dark-field images, corresponding to the diffracted
, with respect to the bright-field image. Thus, the diffracted
passing the selector aperture correspond to specimen areas
h have been shifted relative to that part of the bright-field
ge observed within the selector bore. The resulting shift of the
acting specimen area relative to the selected one can amount
ome tenths of a micron even for diffraction angles of the order
.10^{-2}. Thus, it is inadvisable to use a selected area of diameter
than 1 μ.

8933 ELECTRON TWO-BEAM INTERFERENCE WITH HIGH PATH DIFFERENCE. M.Keller.
hys. (Germany), Vol. 164, No. 3, 292-4 (1961). In German.
.2200 fringes could be counted on a photograph of an electron
ference pattern produced in an electrostatic biprism arrange-
t. Though this number is still far below the theoretical limit
ced from the chromatic inhomogeneity of the electron source,
ceeds by a factor of 7 the highest number of electron inter-
ce fringes hitherto measured.

8934 ELECTRON BIPRISM INTERFERENCE WITH WIDELY SEPARATED COHERENT PARTIAL BEAMS.
ollenstedt and W.Bayh.
rwissenschaften (Germany), Vol. 48, No. 10, 400 (1961).
erman.
By the use of three electron-optical biprisms (charged
ads) instead of one, it proved possible to obtain good inter-
nce fringes with an electron beam split to a separation of as
h as 60 μ. This should make it possible to observe the phase
lacements, which arise when the two partial beams enclose
netic flux, or when one of them passes through a region of
rollable potential. B.Meltzer

18935 SOME MEASUREMENTS ON ENERGY LOSS OF 2.8 MeV ELECTRONS IN LIGHT ELEMENTS AND CHEMICAL COMPOUNDS. T.Westermark.
Ark. Kemi (Sweden), Vol. 17, Paper 10, 101-38 (1961).

Measurements were made of the average energy loss, most probable energy loss and straggling properties of 2.8 MeV electrons in the elements Li, Be, C(graphite), Na, Al, Si and K and the compounds LiH, H_2O, D_2O, benzene, toluene, heptane and methanol. Techniques are described. The theory for stopping power for the elements agrees with experiment within one or two %. A systematic trend indicates some uncertainty with regard to the inclusion of radiation losses in the theoretical estimates in the narrow geometry used. It proved possible to approximate the low-energy tail of the energy loss curve to an exponential function. Straggling liads to broader distributions than those predicted by theory. Reactor graphite shows a large straggling, apparently due toits porosity. The results for organic liquids and water agreed within 1.5% with theoretical calculations. Light and heavy water show the same energy loss per length unit within 0.5%, as expected theoretically. Much work was performed on lithium hydride; absorbers were produced in a hydraulic press giving 6 tons/cm^2 and were handled in a dry atmosphere. The final figure for the stopping power relative to beryllium was 1.176 ± 0.011. This was compared with Brandt's theory for the stopping power of LiH. Using a certain assumption for calculating the density correction, a value for the mean excitation potential $I_{LiH} = 42.5 \pm 4.5$ eV was obtained. This is near Brandt's estimate for the collective excitation model and X-ray data and quantum mechanical calculations of the electron distribution in solid LiH.

ION EMISSION . ION BEAMS

18936 FIRST RESULTS OBTAINED WITH A SOURCE OF HYDROGEN NEGATIVE IONS UTILIZING CHARGE EXCHANGE IN THE GAS. A.de Chateau-Thierry.
C.R.Acad. Sci. (France), Vol. 253, No. 5, 821-3 (July 31, 1961).
In French.

The note describes a source of H^- ions using charge exchange reactions in hydrogen and argon which can produce a current of 3 μA of H^- ions. C.E.Morgan

18937 A SOURCE OF IONS, IN PARTICULAR He^{++}, FOR AN ELECTROSTATIC ACCELERATOR. B.Olkowsky.
J. Phys. Radium (France), Vol. 21, No. 5, 407-9 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Describes an ion source of the Heil-Von Ardenne type. When this source was mounted on the high voltage terminal of the 5 MeV Van de Graaff a 4.8 MeV He^+ and a 9.6 MeV He^{++} beam were obtained, whose intensities were respectively 25 and 5×10^{-2} μA. The power supplied was 16 watts.

18938 MULTICHARGED ION SOURCE FOR A CYCLOTRON. A.Papineau, P.Benezech and R.Maillard.
J. Phys. Radium (France), Vol. 21, No. 5, 410-11 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Describes an ion source with a tungsten cathode heated indirectly by a classical filament and a tungsten reflector. The arc voltage is square-pulsed (2×10^{-2} sec) and the intensity is about 40 A. Preliminary tests allow the estimate that an external beam of N^{5+} (of energy greater than 100 MeV) will be obtained of about 1 μA.

18939 ENERGY DISTRIBUTION OF ARGON- AND HYDROGEN IONS FROM A HIGH FREQUENCY ION SOURCE.
H.Löb.
Z. Naturforsch. (Germany), Vol. 16a, No. 1, 67-75 (Jan., 1961).
In German.

According to Langmuir's classical probe theory, ions extracted from a r.f. plasma ought to have an energy strictly corresponding to the applied extraction potential. Deviations due to thermal motion resulting from the plasma temperature should be below 1 eV. Experimental results, however, do not confirm this theory.

Rather, not one but several discrete ion energies are observed, and the line width in this energy spectrum is found to be two to three orders of magnitude greater than predicted by Langmuir's theory. The ion beam is also modulated by the r.f. excitation. This paper presents a new theory, and substantiates it by a number of careful mass spectroscopic measurements on A^+, H^+, H_2^+ and H_3^+ ions, extracted by a variable voltage between 0 and 5 kV from an ion source excited by a 27 Mc/s field. Energy spectra with up to eight discrete peaks were observed; their amplitude, width, and modulation were evaluated as a function of varying operating conditions of the test equipment. Plasma ions are found to be responsible for the two highest peaks. Two other peaks are the result of charge exchanges between ions in the upper portion of the space charge zone. The distinct separation into plasma ions and space-charge ions is due to the high frequency oscillation of the plasma boundary, which also causes the modulation of the ion current. Two more, smaller peaks are due to collisions with secondary emission electrons in the lower portion of the space-charge zone. Finally, the two smallest peaks are produced by charge exchanges within or near the onset of the ion extractions path. Design, performance, and specifications of the test equipment are described in detail. A thorough analysis of the measured data was carried out. F.R.Walter

18940 INVESTIGATION OF THE EQUILIBRIUM CHARGE DISTRIBUTION IN A FAST ION BEAM.

V.S.Nikolaev, I.S.Dmitriev, L.N.Fateeva and Ya.A.Teplova.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 905-14 (Oct., 1960). In Russian.

The equilibrium distribution of charges in beams of light ions ($Z = 2$-18) and krypton ions that have passed through He, N_2, A, Kr, and a celluloid film, was measured for velocities $v \sim 2.6 \times 10^8$ cm/sec and higher. New information was obtained on the dependence of the mean charge $\bar{i}$ and the distribution width σ on the velocity of the ions, on the charge of their nucleus, and on the medium. Significant differences in the values of $\bar{i}$ in various gases were found for all types of ions. Thus, for ions with $Z > 10$ the value of $\bar{i}$ in a celluloid film exceeds that in gases by 1.6 to 2.3 times. Appreciable deviations from a smooth dependence of $\bar{i}$ and σ on Z were detected in the region $Z \cong 10$-12. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 627-33 (April, 1961)].

NEUTRALIZATION OF ION BEAMS BY INJECTION OF ELECTRONS. See Abstr. 18776-7

18941 PRODUCTION OF MAGNETIC FIELDS USED FOR STRONG FOCUSING BY MEANS OF IRON-FREE COILS.

J.C.Schnuriger.
J. Phys. Radium (France), Vol. 22, Suppl. No. 2, 68A-69A (Feb., 1961). In French.

A method is developed for the calculation of the magnetic field of a straight conductor, whatever the shape of its cross-section; the result is obtained in the form of a series of multipole magnetic fields. This method is applicable to the calculation of iron-free coils giving magnetic fields used in particle optics. It is shown as an example that a quadrupole iron-free lens can be obtained with constant current density such that the first non-linear component of the field is of the ninth order. R.A.Waldron

18942 ON THE DESIGN OF QUADRUPOLE FOCUSING SYSTEMS.

W.Weidemann.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 3, 347-53 (Dec., 1960).

The theory necessary for the design of a quadrupole focusing system for a particle accelerator is set out, followed by a practical design example and the conclusions that can be drawn from the results.

18943 AN ELECTROSTATIC MASS SPECTROSCOPE.

W.Tretner.
Vacuum (GB), Vol. 10, No. 1-2, 31-4 (Feb.-April, 1960).

During the last few years, several methods have been known to analyse the residual gas of high vacuum devices by means of small mass spectrometer tubes. In these tubes which have a resolving power of about 20 or 30, the principle of mass separation by different times of flight is employed. Unfortunately, at pressures below 10^{-6} torr, the signal currents generated by these tubes are so small that for the registration of the whole mass spectrum a comparably long time is required. In order to avoid this drawback a new ma
spectrometer tube was developed. Due to the high signal-output
this tube, the whole mass spectrum, ranging from H^+ up to Hg^+,
can be displayed on an oscilloscope at 50 c/s. Therefore, a prac
tically continuous control of the residual gas can be achieved. T
signal of the mass spectrometer tube is generated by a cloud of charged particles of equal relative masses which oscillates along
the axis of an electrostatic field with axial symmetry. This ion cloud consists of numerous superposed elementary clouds each o
which is created by an electron beam in a strong accelerating fie
near one end of the tube. An electrode on the other end of the tub
is used to pick up the displacement-current induced by the ion cl
The ionizing electron beam is intensity-modulated with a variabl
frequency. Therefore, an ion cloud is built up only when the vari
modulation frequency of the beam coincides with the oscillation frequency of any group of ions. At frequencies other than those
the ions present in the residual gas, the elementary ion clouds cannot form one big cloud because practically no phase relation between them exists. The space-charge action of the elementary clouds explains why the functional dependence between mass inte
sity and partial pressure is not linear. A special tube having a resolving power $m/\Delta m \cong 20$ at all masses, is described which ca
be used at pressures below 5×10^{-5} torr. This upper limit is s
by the mean free path of the ions. The lower limit depends on th
shot noise of the first amplifier stage. Thus, at a registration sp
of 50 c/s, partial pressures in the order of 10^{-8} torr can be dete
At still lower pressures a second operation method should be adopted which even permits the use of an electron multiplier.

18944 ANALYSIS OF PARTIAL PRESSURES BY MEANS OF OMEGATRON AND FARVITRON. COMPARATIVE VIEW OF THE RANGES OF APPLICATION. G.Reich and F.Fle

Vacuum (GB), Vol. 10, No. 1-2, 35-9 (Feb.-April, 1960).

Two partial pressure gauges — the Omegatron and the Farv
(see preceding abstract) — dealt with in the present paper match
each other in an ideal manner. While the Omegatron having high sensitivity and good resolving power allows only the subsequent measuring of single partial pressures, the Farvitron gives a complete survey of the composition of partial pressures on an oscillograph. For this reason the Farvitron having less resolvin
power and lower sensitivity is highly suitable for indicating parti
pressures especially during rapidly varying processes in the pressure range between 10^{-8} and 10^{-5} torr.

18945 THE USE OF A MASS SPECTROMETER IN ELECTR TUBE TECHNOLOGY. R.J.Warnecke, Jr.

Vacuum (GB), Vol. 10, No. 1-2, 49-57 (Feb.-April, 1960). In Fre

After mentioning the use of a mass spectrometer in the stud
of some fundamental problems raised by the technology of the ele
tronic tubes, the author recalls and discusses the characteristic
and performances required of the spectrometers used for the quantitative analysis of the residual gases, the study of their ori
and influence (especially on the cathode behaviour). In order to have valid measurements, the inner structure of the analyser tub
must not modify the composition of the analysed gas; in other wo
it must not have any internal residual gas. Therefore, the spect
meter must have reduced dimensions and the smallest possible surface effects, and it must be possible to outgas the tube energe
ically. These requirements usually exclude the use of classical sector field spectrometers and limit the choice of transit time spectrometers or radio frequency mass spectrometers. Two typ
of spectrometers which can be used with profit are described: t
Omegatron and the Bennett type analyser. The compared perfor
ances and characteristics of these two devices show that their qualities are complementary and that their simultaneous use allo
the analysis concerned to be carried out, both for static and rapi
varying phenomena, within a convenient range of pressure and m

18946 DETERMINATION OF FIELD STRENGTH FOR FIEL EVAPORATION AND IONIZATION IN THE FIELD IO MICROSCOPE. E.W.Müller and R.D.Young.

J. appl. Phys. (USA), Vol. 32, No. 11, 2425-8 (Nov., 1961).

The field strength required for field evaporation of tungsten and for best image conditions in the field ion microscope is meas
ured by comparison with field electron emission by the same emitter. The evaporation field is independent of emitter radius except for radii below 150 A, where the influence of free surface energy becomes noticeable. The field got the best conditions of

um ion image of a typical emitter of 1000 A radius is MV/cm. This field increases gradually with decreasing tip us, so that the ratio of evaporation field to best image field for sten decreases from 1.27 at 1000 A to 1.0 at about 40 A radius. radius dependence of this ratio can be calculated by assuming the time a hopping atom spends in the critical ionization zone constant fraction of the ionization time. Practical implications that large tip radii are preferable for easily evaporating emitter erials, and small radii may be useful when field evaporation is e studied under best image conditions.

8947 THE SPHERICAL CONDENSER AS A HIGH TRANSMISSION PARTICLE SPECTROMETER. II. DISC RCE. R.D.Birkhoff, J.M.Kohn, H.B.Eldridge and R.H.Ritchie. lear Instrum. and Methods (Internat.), Vol. 8, No. 3, 313-19 t., 1960).

For Pt I see Abstr. 1919 of 1961. The inverse square electric between the plates of a charged spherical condenser provides cusing of charged particles leaving a source on the inner sphere. dealt with the characteristics of such a spectrometer for the where the source may be considered concentrated at a point on axis of the instrument. The present analysis is concerned with line profile, the transmission, and the resolution of the spectroer for a distributed source. Where high transmission is important a source on the inner sphere having a radius 30% of the radius e inner sphere provides a transmission of 16% at any energy lution of 7.7%.

8948 A DIFFERENTIAL BEAM COLLECTOR. W.T.H.van Oers. lear Instrum. and Methods (Internat.), Vol. 9, No. 1, 111-12 ., 1960).

A double Faraday cup has been built, which can measure the rgy of a beam of charged particles by determining their mean ge, and which can simultaneously be used to integrate the rent of the beam.

8949 A HIGH TEMPERATURE SPUTTERING ION SOURCE FOR A LABORATORY ISOTOPE SEPARATOR. .Rautenbach. lear Instrum. and Methods (Internat.), Vol. 9, No. 2, 199-211 ., 1960).

The general principles governing the operation of a high perature sputtering ion source are discussed and a technical cription of the ion source is given. Special attention is given ischarge characteristics, ion currents in the sputtered metals, ization of self-sputtering, efficiency in sputtered material and average time spent by sputtered atoms on the walls of the charge chamber. Possible uses for this type of ion source are ussed briefly.

8950 SPUTTERING OF POLYCRYSTALLINE METALS BY INERT GAS IONS OF LOW ENERGY (100-1000 eV). .Weijsenfeld, A.Hoogendoorn and M.Koedam. sica (Netherlands), Vol. 27, No. 8, 763-4 (Aug., 1961).

Extension of previous investigations (Abstr. 4060 of 1959) to cases of Cu, Ni, Fe and Mo bombarded with mono-energetic , A^+, Kr^+ and Xe^+ ions. J.Dutton

8951 EMISSION OF SOFT ELECTROMAGNETIC RADIATION FROM METALS BY THE IMPACT OF HIGH-ENERGY TONS AND POSITIVE IONS. R.M.Chaudhri and M.Y.Khan. re (GB), Vol. 189, 996-7 (March 25, 1961).

Recent experiments of the authors, previously reported, have n that ultraviolet and visible radiation is emitted when positive and protons of moderate energies strike a metal surface. The ent paper describes experiments in which the measurements e extended to protons and positive ions of energies of 400-700 keV. B.Brown

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PARTICLE ACCELERATORS

18952 PULSE-SHORTENING IN ELECTRON LINEAR ACCELERATORS.
M.C.Crowley-Milling, T.R.Jarvis, C.W.Miller and G.Saxon.
Nature (GB), Vol. 191, 483-4 (July 29, 1961).

The possible dependence of pulse-shortening on spurious r.f. modes was difficult to accept for forward waves but has now been shown mathematically to be credible for backward waves where the transverse E and H vectors are additive. Experimental results confirm the presence of such a higher mode when pulse-shortening occurs. Accelerators were built with waveguides which make the generation of higher r.f. modes difficult and these accelerators do not exhibit pulse-shortening. L.E.Mussell

18953 MAGNETIC ANALYSIS OF THE [PROTON] BEAM OF THE 600 keV ELECTROSTATIC ACCELERATOR AT GRENOBLE. J.E.David, J.Krafft, R.Bouchez and N.Felici.
J. Phys. Radium (France), Vol. 21, No. 5, 435-9 (May, 1961).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The analysed proton beam has an energy definition of a few 10^{-3} and an intensity of about 5 μA; the nuclear reactions $Na^{23}(p,\gamma)$ (308 keV), Al^{27}(438 and 504 keV), Li^7(441 keV) were used to calibrate the accelerator. The $B^{11}(p,\gamma)$ resonance width was remeasured, giving $\Gamma_r = (5.4 \pm 1)$ keV.

18954 REALIZATION OF A HIGH-FREQUENCY PHASEMETER.
D.Boussard.
J. Phys. Radium (France), Vol. 22, Suppl. No. 2, 69A-71A (Feb., 1961). In French.

An accurate knowledge of the phase of the accelerating voltage along the machine is necessary for the construction of a linear ion accelerator of the Sloan and Lawrence type, if the length is not very much less than $\lambda/4$. An apparatus is described by which the phase difference between two points of a system of conductors can be measured at high frequency. R.A.Waldron

18955 THE FEASIBILITY OF A SUPERCONDUCTING PROTON LINEAR ACCELERATOR.
A.P.Banford and G.H.Stafford.
Plasma Phys.-Accelerators-Thermonuclear Res. (GB), Vol. 3, No. 4, 287-90 (Oct., 1961).

The use of superconducting resonators for a proton linear accelerator is shown to reduce greatly the r.f. power requirements and, in principle, to make a cm wave high intensity machine practicable. Rough estimates of costs do not preclude the proposal on economic grounds. Some of the technical problems involved are also discussed.

18956 THE LIVERMORE VARIABLE-ENERGY 90-INCH CYCLOTRON.
H.P.Hernandez, J.M.Peterson, B.H.Smith and C.J.Taylor.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 3, 287-302 (Dec., 1960).

A variable-energy cyclotron is described which accelerates protons from 2.6 to 15 MeV, deuterons from 5.2 to 12.5 MeV, and alpha-particles from 10.4 to 25 MeV. The 90-in. diameter magnet incorporates a special fringing field to reduce the angular divergence of the emerging beam. The single dee is driven by a crystal-controlled power amplifier, variable in steps of 55 kc/s from 4.0 to 9.5 Mc/s. The internal beam is limited to 200 μA to avoid septum damage, and 15 to 25% of this beam can be extracted. The external beam has a 2% total spread in energy, and an individual pulse in the beam has a time spread of 2% of the radiofrequency period. Most of the external beam is contained in an elliptical cone with half angles of 0.30° and 0.15°.

18957 THE PRETORIA CYCLOTRON. SECOND REPORT.
J.J.Burgerjon and W.Weidemann.
Nuclear Instrum. and Methods (Internat.), Vol. 8, No. 3, 261-71 (Sept., 1960).

Deals with improvements to the cyclotron, as well as with the extraction and external focusing of the beam. The various components, in so far as they have been subject to alterations, as well as new components, are described. The properties of both the internal and external beams are discussed in separate chapters. Throughout, reference is made to the first report (Abstr. 19842 of 1960).

18958 IMPROVED FOCUSSING NEAR THE CYCLOTRON SOURCE. W.I.B.Smith.

Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 49-54 (Oct., 1960).

The vertical focusing near the ion source was experimentally investigated as a function of the phase of the beam relative to the dee voltage. Considerable improvement in the vertical focusing of the beam was obtained by offsetting the ion source and puller by 20° to the dee edge, and thus retarding by 20° the phase of the first turn.

18959 THE DAMPING OF PARTICLE OSCILLATIONS IN A GENERAL FIELD WITH PERIODIC STRUCTURE. I.

J.Teichman and R.Klíma.

Czech. J. Phys., Vol. 11, No. 5, 307-19 (1961). In Russian.

A linear theory is derived, discussing the dynamics of particles in the region of an equilibrium orbit in a general electromagnetic field, which forms a periodic system. The total particle damping is determined from the Hamiltonian found and from dissipative forces brought out by a classical reaction radiation. Relations for the damping of the synchrotron oscillations are derived from the study of the appropriate phase space.

18960 DEDICATION OF THE CERN PROTON SYNCHROTRON. W.Kliefoth.

Atomkernenergie (Germany), Vol. 5, No. 4, 148-51 (April, 1960). In German.

Describes the dedication ceremony and gives a full description and technical details of the machine. J.W.Sturgess

18961 LOSSES OF ELECTRONS IN SYNCHROTRONS DUE TO THE QUANTUM CHARACTER OF THE RADIATION.

P.S.Landa.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1119-23 (April, 1961). In Russian.

By means of an approximate solution of the nonstationary Fokker—Planck equation, an explicit expression which includes effects of the nonlinearity of the phase oscillations, is obtained for the probability of electron loss. It is shown that inclusion of the nonlinearity leads to an increase of the probability of electron loss, but this increase is quite insignificant and of the order of unity. A simple approximate formula for calculating electron-loss probabilities is proposed. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 789-91 (Oct., 1961)].

18962 ON THE PARTICLE LOSS AT A SYNCHROCYCLOTRON LIMIT RADIUS.

V.P.Dmitrievsky, V.V.Kolga and B.I.Zamolidchikov.

Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 115-17 (Oct., 1960).

Resonance interaction of radial and vertical oscillations near $n = 0.25$ is considered. This resonance is shown to be more dangerous than a parametric excitation of vertical oscillations which is caused by the first harmonic in the magnetic field structure.

18963 THE OPTIMUM LENGTH OF A MICROTRON ACCELERATING GAP. A.Paulin.

Nuclear Instrum and Methods (Internat.), Vol. 9, No. 1, 113-14 (Oct., 1960). In German.

The optimum length of the accelerating gap using a field emission cathode was calculated. For the s-band microtron this length should be 5 mm in the 511 keV mode ($a = 2$) and 4 mm in the 255 keV mode ($a = 3$).

18964 PHASE- AND VERTICAL STABILITY OF MICROTRONS. É.Kisdi-Koszó and L.Turi.

Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 137-40 (Nov., 1960).

The phase- and vertical stability of an 8 orbit, 2 MeV microtron are investigated and it is found that owing to the poor phase stability only 7% of the current intensity remains available for acceleration. The vertical drift causes further losses amounting to 90% of the current intensity. The actual output of the apparatus is 0.4% of t electron current fed into the first orbit. A simple method is proposed for improving the phase stability.

18965 A HIGH CURRENT MICROTRON. S.P.Kapitza, V.P.Bÿkov and V.N.Melekhin.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 997-1000 (Oct. 1960). In Russian.

Preliminary data are presented in a efficient electron cyclo in the 5-15 MeV energy range. The efficiency of electron captur into resonance orbits and also the general efficiency of the accelerator are appreciably increased by injecting the electrons from a hot cathode located directly in the cavity. The accelerate electrons are well defined in energy and momentum. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 693- (April, 1961)].

18966 AN EFFICIENT LARGE CURRENT MICROTRON. S.P.Kapitsa, V.P.Bÿkov and V.N.Melekhin.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 368-84 (Aug., 19 In Russian.

Considers the construction of a high current microtron in w electrons are accelerated up to energies 6-13 MeV, the pulse currents being 20-5 mA respectively. The conditions of operatio an efficient thermal cathode made of lanthanum boride in the high frequency field of the accelerating cavity are examined. The efficiency of the accelerator is estimated and the main paramete of the latter, derived by calculations and confirmed experimental are presented. [English translation in: Soviet Physics—JETP (USA)].

X-RAY TUBES AND TECHNIQUES

18967 AN EXPERIMENTAL APPARATUS FOR CONTACT MICRORADIOGRAPHY AT 200-500V.

A.Recourt and G.H.F.de Vries.

Nature (GB), Vol. 191, 1185-6 (Sept. 16, 1961).

This consists of a windowless X-ray tube having a 100 μ diameter wire as anode surrounded by a circular grid with a fila ment mounted on a sintered glass plate. The soft X-rays enter camera, which is mounted close to the anode, through a light-tig evaporated aluminium membrane (500 A). A spring holds the photographic plate in contact with the collodion film carrying the object against a spacing ring. The soft radiation microradiogra provides information about mass and chemical composition.

V.R.Swit

18968 COMPARISON OF THE LIGHT OUTPUT OF IMAGE INTENSIFIER TUBES. G.C.Henny and J.A.Becker.

Radiology (USA), Vol. 77, No. 3, 472-9 (Sept., 1961).

Four image-intensification tubes are compared with respect roentgens per minute at the primary screen against millilambert the secondary screen ("efficiency"). The parameters for the brightness levels from the input X-ray aspect (kilovolts, milliamperes, per minute) and from the image intensifier tube aspect (photocathode current, i.e. microamperes) are compared with the brightness produced at the output phosphor screen. From these data, the two screens of the intensifier tubes are evaluated. At t normal operating level (80-100 kvp) of image-intensifier tubes variations in milliamperage and r per minute produce little chan in the efficiency of tube operation. However, at either low or hig kilovoltage, the ability of the tube to convert X-rays into light fa off. No tube tested had a combination of the most responsive inp screen and the most responsive output phosphor, which would be optimal for peak efficiency. However, in final judgment, the tube with the greatest light output per incident r per minute ("efficien is the most desirable, regardless of how this effect is produced. observations indicate that the "efficiencies" of the various tubes a directly dependent on phosphor screen efficiences.

INTENSITY CALIBRATION OF 2-METRE CURVED-CRYST SPECTROMETER. See Abstr. 16738

18969 DETERMINATION OF CERTAIN SPECTRAL DISTRIBUTIONS OF SOFT X RAYS BY THEORETICAL
ALYSIS OF ABSORPTION EXPERIMENTS. N.A.Kerr.

ppl. Phys. (USA), Vol. 32, No. 11, 2465-74 (Nov., 1961).

The temperature of a black-body source which emits continuous liation with a spectral peak in the range 0.6 to 8 keV in photon rgy (soft X-rays), may be determined by analysing an absorption eriment. The technique employed here may be useful in analysis ther continuous radiation distributions of soft X-rays (e.g. free— e continuum radiation from plasma discharges and deceleration liation from thick targets). Use is made of the approximation t over a limited energy-region the absorption coefficient varies ersely with the cube of the spectral energy. The equation

$$I(x) = I_0(1 + C_1x \log_e x + C_2x + C_3x^{4/3}),$$

lecting terms of magnitude $C_4x^{5/3}$ or less for thin absorbers, cribes the relative dependence of the transmitted X-ray intensity on the absorber thickness x for a black-body spectrum of incit intensity I_0. The constants C_1 to C_3 are related in a known nner to the temperature of the black-body source for a given abber material. Similarly, the equation,

$$I(x) = I_0D_1x^{7/8}(1 + D_2x^{-1/4}) \exp(-D_3x^{1/4}),$$

le ting terms of magnitude $D_4x^{-1/2}$ or less for thick absorbers, cribes the transmission of a black-body spectrum characterized a source temperature which may be determined from the connts D_1 to D_3.

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

18970 REVIEW OF HALL PROBES.
F.Kohout and I.Weiss.

atsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 1, No. 7-10, 8 (1959). In German.

Gives a general review of the construction and uses of Hall bes for various experimental purposes. C.A.Hogarth

8971 CONCERNING THE PAPER BY D.D.VOEIKOV ON "METHOD OF IMPROVING THE STABILITY OF THE
LL EFFECT PROBES". V.V.Serkov.

. tverdogo Tela (USSR), Vol. 3, No. 4, 1253-4 (April, 1961). ussian.

It is shown analytically that contrary to the view, implied in ikov's paper (Abstr. 8142 of 1959), the influence of the out-ofnce condition of a Hall-effect probe on the accuracy of its dings cannot be reduced by increasing the stability of the probe. glish translation in: Soviet Physics—Solid State (USA), Vol. 3, 4, 909 (Oct., 1961)]. M.H.Sloboda

8972 ON THE DEMAGNETIZING FACTOR OF CYLINDRICAL RODS. Y.Shirakawa.

Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 3, 219-25 e, 1960).

The ballistic demagnetizing factor of cylindrical rods of ferronetic substances, whose dimension ratio is smaller than 10, was erimentally determined by a new method using the demagnetizing ve of a new K.S. magnet alloy having a high coercive force. The tionship between the demagnetizing factor, N, and the dimension o, m, was expressed as follows: $N = 5.5(m + 0.54)^{-1.4}$, $m < 10$.

8973 ELECTRON DIFFRACTION METHOD FOR THERMOMAGNETIC ANALYSIS. S.Yamaguchi.

nstrumKde (Germany), Vol. 69, No. 8, 224-6 (Aug., 1961). erman.

The method described measures the magnetic induction in Invar 64 : Ni/Fe) and in nickel, as a function of temperature, and uses uble photographic exposure, one with the specimen cold, the ond with it hot. From measurement of the eccentricity of the two sets of diffraction rings on the photograph, the corresponding change of magnetic induction can be calculated. Using the method, the magnetic transformation diagram for the Ni/Fe system can be obtained. In the diagram given, the Ni content varies from 36 to 100%, and the temperature from 50 to 600°C. A description is given of use of the thermo-magnetic electron diffraction method to demonstrate the magnetic anisotropy of the crystal lattice of cobalt. C.F.Pizzey

18974 THE STABILIZATION OF A MAGNETIC FIELD BY A NUCLEAR MAGNETIC RESONANCE MASER. I.
P.Grivet and H.Hahn.

Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 233-41 (Nov., 1960). In French.

Deals with a new system for regulating the magnetic field of an electromagnet, with an accuracy significantly superior to the limit accessible with a current regulator. The essential element is a nuclear resonance maser using a liquid stream for linking the magnetic field with the frequency of a radio signal generated by the maser. Describes the structure and the relevant properties of this peculiar form of maser. The theory is compared with the measured values obtained with the equipment described in the following abstract.

18975 THE STABILIZATION OF A MAGNETIC FIELD BY A NUCLEAR MAGNETIC MASER. II.
P.Grivet and H.Hahn.

Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 3, 328-40 (Dec., 1960). In French.

Describes the various parts of the regulator built around the maser oscillator discussed in the preceding abstract. It consists of a quartz frequency standard, the frequency modulation and the feed back loop. A long term stability ±6 × 10^{-7} is obtained with a laboratory electromagnet of poor spatial uniformity and could be improved with a better magnet.

18976 NEW DEVELOPMENTS IN HIGH-MAGNETIC FIELD RESEARCH. F.Bitter.

Phys. Today (USA), Vol. 14, No. 9, 22-8 (Sept., 1961).

Review article.

18977 PRODUCTION OF AN AZIMUTHALLY VARYING MAGNETIC FIELD. R.A.Meshcherov and E.S.Mironov.

Atomnaya Energiya (USSR), Vol. 10, 127 (1961). In Russian. English translation in: Plasma Phys.—Accelerators—Thermonuclear Res. (GB), Vol. 3, No. 4, 297-300 (Oct., 1961).

A method is given for calculating the shape of the pole surface required to produce an azimuthally varying magnetic field having a given depth and mean magnetic field intensity variation. Model experiments on a 1.5 m cyclotron having an azimuthal magnetic field variation are described.

18978 DESIGN OF LARGE PERMANENT MAGNETS WITH ROTATIONALLY SYMMETRICAL POLES.
D.Ugrin-Šparac.

Z. angew. Math. Phys. (Switzerland), Vol. 12, No. 1, 38-53 (Jan. 25, 1961).

By using "reduced" dimensions generalized expressions are obtained which can be used for the design of either large or small magnets provided certain optimum conditions are fulfilled. Two examples of design are given, one for an existing magnet (good agreement is obtained) and the second for a magnet to be constructed. E.G.Knowles

18979 THE APPLICATION OF A FLUXGATE MAGNETOMETER TO AN AUTOMATIC ELECTRONIC
DEGAUSSING SYSTEM. R.L.Graham and J.S.Geiger.

Canad. J. Phys., Vol. 39, No. 9, 1357-68 (Sept., 1961).

The three-component fluxgate magnetometer developed by Serson (Abstr. 2062 of 1958) was adapted to provide continuous correction signals to the degaussing system of the Chalk River iron-free β-ray spectrometer. Improved electronic circuitry was developed for the magnetometer which minimizes the zero error and reduces to < 10^{-4} gauss long-term drift caused by component aging. The degaussing coil arrangement used to generate uniform magnetic field components opposite to those of the earth is indicated and the current regulation system is described briefly. The method in which the magnetometer correction signal is introduced into the current regulators is shown and an example is given of the performance of this degaussing system during a magnetic storm.

18980 THE TRANSFER OF ENERGY FROM A LONGITUDINAL A.C. MAGNETIC FIELD TO A TORSION PENDULUM WITH A FERROMAGNETIC SUSPENSION.

B.Rothenstein and J.Hrianca.

Czech. J. Phys., Vol. 11, No. 3, 179-85 (1961). In German.

Quotes measurements obtained on suspensions consisting of copper wire on which nickel layers of various thicknesses had been deposited by electrolysis. The results show that the values obtained for the internal friction can fall below those which correspond to magnetic saturation. Under favourable conditions forced oscillations may be produced. R.Parker

ELECTROMAGNETISM
MAGNETOHYDRODYNAMICS

18981 COMPLEMENT TO A STUDY OF ELECTROMAGNETIC POINT SOURCES. M.Bouix.

Ann. Telecomm. (France), Vol. 16, No. 3-4, 105-7 (March-April, 1961). In French.

In the previous paper [Abstr. 1132 B of 1960; Ann. Telecomm. (France), Vol. 14, No. 5-6, 143-50 (May-June, 1959)], the author showed how to find those distributions of electric and magnetic current on a spherical surface which would give rise to a given field distribution in space. It is now shown that only two of the doubly infinite set of solutions there derived correspond to true point sources, since all the others require the spherical surface to possess a finite radius in order that they may exist. G.D.Sims

18982 THE ELECTROMAGNETIC FIELDS OF A HORIZONTAL DIPOLE IN THE PRESENCE OF A CONDUCTING HALF-SPACE. J.R.Wait.

Canad. J. Phys., Vol. 39, No. 7, 1017-28 (July, 1961).

The problem considered is a horizontal electric dipole which is located above or below the plane surface of a conducting half-space. Expressions for the fields are obtained using three different approaches. The formulae developed are quite simple and, taken together, the whole range of distances from the far-zone to the near-zone is adequately covered.

18983 ON THE FIELD—MATTER INTERACTION IN CLASSICAL ELECTRODYNAMICS.

I.Prigogine and B.Leaf.

Bull. Acad. Roy. Belgique Cl. Sci., Vol. 46, No. 11, 915-28 (1960).

A method for treating electrodynamic problems in terms of the Liouville equation, developed by the authors in a preceding paper (Abstr. 19882 of 1960), is here applied to the case of a non-relativistic harmonic oscillator coupled to its own radiation field. The Hamiltonian operator first is written in action-angle variables; the associated Liouville equation is then discussed by perturbation methods. The evolution of the reduced phase-space density of the particle is calculated to second order. Classical results on oscillator damping are recovered. The coupling to the radiation field induces an infinite negative frequency shift which is interpreted as a mass renormalization. T.Erber

18984 GENERALIZATION OF THE KRAMERS—KRONIG FORMULAE TO MEDIA WITH SPATIAL DISPERSION.

M.Leontovich.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 907-12 (March, 1961). In Russian.

A condition that must be satified by the complex electric permittivity of a medium with spatial dispersion, and that generalizes the Kramers—Kronig formulae, is derived by requiring satisfaction of the causality principle in a form following from the theory of relativity. The conditions obtained, in contrast to the Kramers—Kronig formulae, not only relate the real and imaginary parts of the permittivity to each other but also impose restrictions on each of them separately. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 634-7 (Sept., 1961)].

18985 A CERTAIN MECHANISM FOR ABSORPTION OF ENERGY BY ANISOTROPIC BODIES. M.Sh.Giterma

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 507-11 (Aug., 196 In Russian.

A body located in a varying external field may execute perio motion by absorbing the field energy and dissipating it in the viscous medium if its magnetic susceptibility or electric polariz bility is anisotropic. The dependence of the absorption coefficie on the frequency of the external field is of a resonant nature. In particular, only periodic oscillations of freezing nuclei of a cert size are possible for the liquid—solid transition. [English transl tion in: Soviet Physics—JETP (USA)].

18986 DRIFT VELOCITY OF A CHARGED PARTICLE IN A INHOMOGENEOUS MAGNETIC FIELD. J.Hurley.

J. appl. Phys. (USA), Vol. 32, No. 11, 2368-9 (Nov., 1961).

Alfvén [Cosmical Engineering (Oxford, 1950)] and Spitzer (Abstr. 4222 of 1953) obtained an expression for the drift velocit of a charged particle in an inhomogeneous magnetic field. The result is correct to first order in the ratio of the drift velocity t the particle velocity. A class of fields is presented for which th drift velocity may be calculated exactly.

18987 DRIFT RATE IN A DIPOLE FIELD.
J.S.Lew.

J. geophys. Res. (USA), Vol. 66, No. 9, 2681-5 (Sept., 1961).

Expressions are found for the drift of charged particles in t field of a magnetic dipole. These give, in the guiding centre appr mation, the longitude drift rate and drift period of relativistic particles with mirror points at any latitude. The results are applied to trapped electrons and protons in the earth's magnetic field, and are adapted for further use in such applications.

18988 VARIATION OF THE ADIABATIC INVARIANT OF A PARTICLE IN A MAGNETIC FIELD. II.

A.M.Dȳkhne and A.V.Chaplik.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 666-9 (Feb., 1961) In Russian.

For Pt I, see Abstr. 2013 of 1961. The change in the adiaba invariant during passage of a charged particle through a magneti inhomogeneity is calculated. The results significantly differ fro those obtained with help of a model Hamiltonian. [English transl tion in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 465-7 (Aug., 1961)].

18989 CHANGE IN THE MOMENTA OF CHARGES COLLID IN A MAGNETIC FIELD. Yu.N.Barabanenkov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1476-80 (May, 196 In Russian.

Scattering of two charged particles in a homogeneous and ti independent magnetic field is examined under the assumption of Coulomb interaction. The change in the particle momenta on scattering is calculated. It is shown that for two like charges th momentum change decreases according to an exponential law wi increase of the impact parameter. Because of Larmor resonanc the momentum change of opposite charged particles decreases according to a power law with increase of the impact parameter The magnetic field screens the interaction between the particles during scattering. A graphic interpretation of this type of effect the magnetic field would be equivalent to spherically symmetric potentials. In the case of like charges these would be of the Deb type; in the case of opposite charges these potentials would be o power type. [English translation in: Soviet Physics—JETP (US

18990 PECULIARITIES OF MOTION OF CHARGED QUASI- PARTICLES IN A VARIABLE AND INHOMOGENEOU ELECTROMAGNETIC FIELD.

I.M.Lifshits, A.A.Slutskin and V.M.Nabutovskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 939-48 (Sept., 1 In Russian.

Considers the motion of charged quasi-particles in electric magnetic fields slowly varying in time and space. "Averaged" e tions of motion are deduced and investigated for various geomet of the isoenergetic surfaces. Singularities of the motion near sa points in p-space are investigated. A peculiar scattering phenor arises in this case which is not related to the presence of a forc centre in coordinate space. The probabilities of the particles er regions with various conditions of motion are evaluated. [English slation in: Soviet Physics—JETP (USA)].

8991 THE HAMILTONIAN OF AVERAGED MOTION. E.L.Burshtein and L.S.Solov'ev.
1. Akad. Nauk SSSR, Vol. 139, No. 4, 855-6 (Aug. 1, 1961). ussian.

In the solution of many problems of plasma dynamics, the ry of oscillations, etc., extensive use is made of approximate hods based on the averaging of the corresponding equations with pect to time or one of the space coordinates. If the averaged ations obtained in this way are expressed in the form of ilton's canonical equations, then their first integral may be ined directly. An account is given in this article of the method btaining the averaged canonical equations. The method is strated by two examples from electrodynamics. [English slation in: Soviet Physics—Doklady (USA)]. A.J.McTernan

8992 EQUILIBRIUM AND STABILITY FOR TOROIDAL MAGNETOHYDRODYNAMIC SYSTEMS UNDER LAR PRESSURE IN THE NEIGHBOURHOOD OF A MAGNETIC S. C.Mercier and M.Cotsaftis.
. Acad. Sci. (France), Vol. 252, No. 15, 2203-5 (April 10, 1961). rench.

The equations giving the equilibrium conditions are developed general stability criteria are deduced. It is found that no librium exists if the angle of the rotational transform is a tiple of 2π. G.Martelli

8993 MOTION OF A MEDIUM WITH FINITE CONDUCTIVITY IN THE PRESENCE OF A UNIFORM MAGNETIC FIELD.
.Sharikadze.
l. Akad. Nauk SSSR, Vol. 138, No. 4, 817-19 (June 1, 1961). ussian.

For abstract, see Abstr. 16523 of 1961. [English translation Soviet Physics—Doklady (USA), Vol. 6, No. 6, 470-1 (Dec., 1961)].

18994 THE STABILITY OF AN INFINITELY CONDUCTING LIQUID COLUMN WITH UNIFORM VOLUME RENT AND SURFACE CHARGE.
.Chakraborty and P.L.Bhatnagar.
c. Nat. Inst. Sci. India A, Vol. 26, No. Suppl. 2, 76-88 (Dec., 1960).

Investigated for an infinite column in two special cases. In the t case the liquid cylinder is taken to be surrounded by vacuum assumed to be nongravitating, and the surface tension forces taken into account. This case is an idealization of problems can probably be realized under laboratory conditions. In the nd case the conducting cylinder is taken to be gravitating and ounded by a nonconducting fluid that extends to infinity, and ace tension effects are neglected. This case may be an ideali-on of situations occurring on a cosmic scale. The dispersion rela- is thoroughly discussed in the first case. It is found that in the of axisymmetric disturbances there exists a range of wave num- depending on the magnitude of the surface charge density and ace tension for which disturbances are unstable. When azimuthal e number $m \geq 2$, there is always stability. When $m = 1$, it is d that for small wave numbers there is always instability. In second case only axisymmetric disturbances are discussed and found that there is a range of the magnitude of the surface ge density for which disturbances of all wave numbers are able, and for surface charges outside this range the disturbances stable if the wave number lies in certain definite intervals.

8995 ON THE STABILITY OF A RIGIDLY ROTATING LIQUID COLUMN WITH AXIAL MAGNETIC FIELD.
Chakraborty.
dian Inst. Sci., Vol. 43, No. 2, 112-30 (April, 1961).

The problem of the stability of a uniformly rotating column of itely conducting, inviscid liquid is investigated in the presence uniform axial magnetic field. The dispersion relation is de- d taking account of both the self-gravitation and surface tension es. The discussion of stability is, however, limited to axisym- ic long wave disturbances in a cylinder devoid of surface ten- . It is shown that a non-gravitating cylinder is stable or un- le depending upon whether the velocity of rotation is small or e compared to the Alfvén velocity. Further a gravitating der under rotation is also found to be unstable. S.P.Talwar

18996 HYDROMAGNETIC FLOW IN THE CIRCULAR-CYLINDRICAL TUBE. J.Uhlenbusch and E.Fischer.
Z. Phys. (Germany), Vol. 164, No. 2, 190-8 (1961). In German.

An exact solution is obtained for the hydromagnetic equations for a viscous incompressible electrically conducting fluid flowing along a cylindrical tube placed at right angles to a uniform applied magnetic field. The solution takes the form of an infinite series of imaginary-argument Bessel functions, For small applied field, this solution is expanded in powers of the Hartmann number. O.Penrose

18997 STABILITY OF MAGNETIC TANGENTIAL DISCONTINUITIES IN RELATIVISTIC HYDRODYNAMICS.
M.T.Zhumartbaev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1434-9 (May, 1961). In Russian.

Small perturbations of the discontinuity surface in relativistic magnetohydrodynamics are examined. It is shown that in the case of small perturbations the magnetic tangential discontinuity is retained. Stability of magnetic tangential discontinuities is investigated. In particular, their instability region is determined in the ultrarelativistic case. [English translation in: Soviet Physics—JETP (USA)].

18998 RELATIVISTIC MAGNETOHYDRODYNAMICS AND IRREVERSIBLE THERMODYNAMICS. W.F.Hughes.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 4, 878-89 (Oct., 1961).

The basic equations of non-relativistic magnetohydrodynamics are briefly reviewed. Beginning with the energy—momentum tensor for the coupled electromagnetic and fluid fields, relativistic energy and momentum equations are formulated. The effect of heat conduction is included and relativistic constitutive equations are discussed. A relativistic first law of thermodynamics is developed in terms of internal energy and entropy. Finally, the second law and entropy production rate are derived in a covariant fashion.

18999 THE STABILITY OF VISCOUS FLOW IN A CURVED CHANNEL IN THE PRESENCE OF A MAGNETIC FIELD. S.Chandrasekhar, D.D.Elbert and N.R.Lebovitz.
Proc. Roy. Soc. A (GB), Vol. 264, No. 1317, 155-64 (1961).

The stability of viscous flow between two coaxial cylinders maintained by a constant transverse pressure gradient is considered when the fluid is an electrical conductor and a uniform magnetic field is impressed in the axial direction. The problem is solved and the dependence of the critical number for the onset of instability on the strength of the magnetic field and the coefficient of electrical conductivity of the fluid is determined.

19000 MAGNETOHYDROSTATIC EQUILIBRIUM FOR FLUID ENCLOSED IN AN AXISYMMETRIC TOROIDAL SURFACE. Y.Kato.
Progr. theor. Phys. (Japan), Vol. 26, No. 1, 123-30 (July, 1961).

The solution of the magnetohydrostatic equations for an ideally conducting fluid contained in an axisymmetric toroidal surface is investigated. The basic equations are reduced to a partial differential equation of the second order, of two variables and of elliptic type. This equation contains two arbitrary functions which give nonlinear terms. The Dirichlet problem for this equation has a solution according to Nagumo's theorem and the solution gives the equilibrium. The vacuum field sustaining the equilibrium is examined for a toroidal fluid with circular cross-section.

19001 THE STABILITY OF A SELF-GRAVITATING FLUID SPHERE IN PRESENCE OF A MAGNETIC FIELD.
F.C.Auluck and N.K.Nayyar.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. Suppl. 2, 1-9 (Dec., 1960).

A magnetic field configuration is found which can keep a gravitating fluid sphere in equilibrium. Its stability in the presence of such magnetic fields is discussed; it is found that the sphere is stable under all P_l deformations.

19002 2nd SYMPOSIUM ON THE ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS.
G.W.Sutton and P.Gloersen.
Phys. Today (USA), Vol. 14, No. 9, 18-21 (Sept., 1961).

Report of a conference held at the University of Pennsylvania on March 9-10, 1961. There were four sessions under the following titles: Flight Applications; Power Conversion; Communications and Diagnostics; Fusion. Each session included a number of invited papers followed by contributed papers.

19003 MAGNETOHYDRODYNAMIC CHANNEL FLOW UNDER TIME-DEPENDENT PRESSURE GRADIENT.

J.T.Yen and C.C.Chang.
Phys. of Fluids (USA), Vol. 4, No. 11, 1355-61 (Nov., 1961).

Hartmann's work on magnetohydrodynamic channel flow is extended to include the case with a time-dependent pressure gradient. Cases treated are: (a) suddenly applied pressure gradients which are periodic in time, and (b) pressure gradients which, with respect to time, are step and delta functions. The channel walls are assumed to be perfectly conductive. As a limiting case, the solution for hydrodynamic channel flow with a time-dependent pressure gradient is also given. The nature of viscous and magnetic drag on the wall is discussed. By use of the convolution integral and superposition principle, solutions can be obtained for any arbitrary time-dependent pressure gradient. Figures show the physical consequence of the solutions.

19004 HYDROMAGNETIC STABILITY OF TOROIDAL EQUILIBRIA WITH AN EXTERNALLY IMPOSED ROTATIONAL TRANSFORM.

J.L.Johnson and J.M.Greene.
Phys. of Fluids (USA), Vol. 4, No. 11, 1417-26 (Nov., 1961).

An expansion technique is employed to study the stability condition for toroidal hydromagnetic configurations in which the curvature of the system, the rotational transform per unit length, and the pressure which is contained in the system can be treated as small. The most general condition which is necessary for stability with respect to localized perturbations is obtained as a ratio of two infinite determinants.

TWO-DIMENSIONAL SUPERSONIC JET OF A CONDUCTING INVISCID GAS IN THE PRESENCE OF A UNIFORM MAGNETIC FIELD. See Abstr. 18377

19005 ELECTROHYDRODYNAMIC AND MAGNETOHYDRODYNAMIC SURFACE WAVES AND INSTABILITIES.

J.R.Melcher.
Phys. of Fluids (USA), Vol. 4, No. 11, 1348-54 (Nov., 1961).

Low-frequency dynamics of a plane fluid interface stressed by tangential or perpendicular electric or magnetic fields is studied emphasizing the duality of the magnetic and electric cases. Both configurations are shown to be controlled by an effective Alfvén velocity for the magnetic cases, and by an electrohydrodynamic dual to this velocity for the electric cases. A wavelength and threshold for instability are predicted for a surface stressed by a perpendicular field, and correlated with experimental results. This makes possible a critical experiment to determine the nature of interfacial electrostriction in dielectrics. A dielectric interface stressed by a tangential electric field supports incompressible electrohydrodynamic transverse waves that propagate along the lines of electric field intensity at a velocity strongly influenced by interfacial electrostriction. Experimental results indicate the existence of such waves.

19006 HYDROMAGNETIC WAVES IN A COMPRESSIBLE FLUID.

C.Devanathan and P.L.Bhatnagar.
J. Indian Inst. Sci., Vol. 43, No. 4, 179-94 (Oct., 1961).

The equations satisfied by vorticity and current density are derived for a compressible infinitely conducting fluid in the presence of a magnetic field. It is shown that the components of vorticity and current density along the direction of the magnetic field will be propagated with Alfven velocity only if the charge separation takes place in the medium. The propagation of the distribution caused by homogeneous and inhomogeneous condensations at a point in the medium are considered. Finally, a proof is given of Walen's problem namely that an annular disturbance is propagated along the magnetic lines of force with Alfven velocity without distortion.

19007 ALFVÉN WAVES IN PARTIALLY IONIZED GASES.

T.Watanabe.
Canad. J. Phys., Vol. 39, No. 8, 1197-1211 (Aug., 1961).

Obtains the conditions for a wave, propagated in a partially ionized gas along an external magnetic field, to be of Alfvén type.

19008 WAVES IN A RAREFIED IONIZED GAS PROPAGATED TRANSVERSE TO AN EXTERNAL MAGNET
FIELD.

T.Watanabe.
Canad. J. Phys., Vol. 39, No. 7, 1044-57 (July, 1961).

Waves being propagated in a rarefied and fully ionized gas a
transverse to an external magnetic field were studied, particula
hydromagnetic waves. Three modes of waves, in which the
perturbed magnetic field is parallel to the external magnetic
field, are found to be propagated. In a high-frequency limit, they
tend to electromagnetic waves, electron sound waves, and ion
sound waves. In the condition that the Alfvén velocity is greater
than the ion sound velocity but smaller than the light velocity,
the last mode tends to a hydromagnetic wave in the low-frequenc
limit. The other two modes of waves can be propagated only at
frequencies higher than the critical frequencies, both of which
almost equal the electron plasma frequency. The condition that
hydromagnetic waves should be attenuated severely due to collisi
between electrons and ions has been derived.

19009 THEORY OF SIMPLE FINITE AMPLITUDE MAGNET
HYDRODYNAMIC WAVES IN A DISSIPATIVE MEDIU

S.I.Soluyan and R.V.Khokhlov.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 534-43 (Aug., 19
In Russian.

The propagation of magnetoacoustic waves of finite amplitud
analysed by taking into account dissipation of energy in the medi
The method of analysis is based on a simplification of the initial
magnetohydrodynamical equations which are valid for small initi
perturbations and small energy dissipation. The concept of simp
waves is extended to the case of dissipative media. The formatic
and "smearing out" of wave fronts are studied for different types
wave configurations. The spatial dimensions of the phenomena a
determined. [English translation in: Soviet Physics—JETP (USA

19010 REFLECTION OF A WEAK SHOCK WAVE IN A PERFECTLY CONDUCTING GAS.

S.Morioka.
J. Phys. Soc. Japan, Vol. 16, No. 9, 1794-5 (Sept., 1961).

Extends the work of Bleakney and Taub (Abstr. 2266 of 1950) to t
problem of regular reflection of a weak plane shock wave, propa-
gating in a perfectly conducting gas, from a solid wall, when ther
is a magnetic field parallel to the wall. Numerical calculations
from the theory support the conclusion that the presence of the fi
increases the range of shock angle in which regular reflection
can occur. M.McChesı

19011 FUNDAMENTAL RELATIONS ACROSS A STRONG STEADY SHOCK WAVE GIVING RISE TO A DISCONTIN
IN CONDUCTIVITY.

Yu.L.Zhilin.
Priklad.Mat. i. Mekh. (USSR), Vol. 24, No. 3, 543-6 (1960). In Russi
English translation in: J. appl. Math. Mech., Vol. 24, 794-800.

Consider a plane, stationary shock on which is incident a
stream of an inviscid, non-heat-conducting, non-electrically con-
ducting gas with a given arbitrary electromagnetic field. Furthe
assume that, far behind the shock wave, the electrical conductiv
of the gas is infinite. In the paper under review, the basic relati
that connect the values of the physical variables on two sides of t
shock wave system described above are obtained and discussed f
some particular cases of interest.
Mathematical Reviews (O.P.Bhuta

19012 THE MOTION OF SHOCK WAVES ALONG A MAGNETIC FIELD.

R.V.Polovin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1005-7 (Oct., 1960). In Russian.

A shock wave is considered that is excited in a magnetohydr
dynamic medium by a conducting piston moving along the magnet
field. The conditions are found under which the shock wave
becomes non-evolutionary and splits into two magnetohydrodynar
waves. The supposition is put forward that such a disintegration
is one of the ways of forming filamentary nebulae. [English
translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 699-
(April, 1961)].

19013 SHOCK WAVES IN RELATIVISTIC MAGNETOHYDRODYNAMICS.

L.M.Kovrizhnÿkh.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1042-5 (Oct., 1960). In Russian.

The properties of a shock adiabat in relativistic magnetorodynamics are investigated for the case of perpendicular waves. number of limiting cases some simple expressions are ived which relate the thermodynamic quantities on both sides of scontinuity. The possibility of accelerating charged particles neans of shock waves is briefly considered. It is shown that in ultrarelativistic case of perpendicular waves such acceleration mpossible. [English translation in: Soviet Physics—JETP A), Vol. 12, No. 4, 725-7 (April, 1961)].

ELECTROMAGNETIC WAVES AND OSCILLATIONS

(See also Plasma Oscillations)

19014 THE DEFINITION OF ELECTROMAGNETIC RADIATION. F.Rohrlich.

ovo Cimento (Italy), Vol. 21, No. 5, 811-22 (Sept. 1, 1961).

The momentum and energy of e.m. radiation emitted from a irge are Lorentz-covariantly defined. The non-local measurent of a Lorentz invariant, the rate of radiation-energy emission, proposed as a necessary and sufficient criterion for the ission of radiation at a given time. This measurement is a field asurement which can be performed at any distance from the irge and need not be made in the wave zone. It can be regarded an operational definition of radiation in terms of rate of energy ission. These results permit a simple derivation of the equation motion of a charged particle which avoids the self-energy ficulties. A question concerning the principle of equivalence and liation in uniformly accelerated motion is answered.

PHASE OPERATORS IN RADIATION THEORY.
Abstr. 18554

19015 SOME PRELIMINARY EXPERIMENTAL TESTS OF A NOVEL METHOD OF RADIATING AT VERY LOW EQUENCIES. R.N.Gould.

ure (GB), Vol. 190, 332-3 (April 22, 1961).

Describes the use of a long narrow peninsula (in Loch Longreloch area) composed of poorly conducting material, as a liator at v.l.f. The cable energizing the radiator was placed oss the root of the peninsula, its ends were earthed in the sea l power was fed into its mid-point. The transmitter delivered W at 10 kc/s. Genuine radiation effects were observed and an empt was made to determine the impedance characteristics of radiator. J.K.Skwirzynski

19016 CROSS-RELAXATION EFFECTS IN A RUBY L-BAND (1440 Mc/s) MASER AT LOW MAGNETIC FIELDS.

S.Bogle and F.F.Gardner.

istral. J. Phys., Vol. 14, No. 3, 381-402 (Sept., 1961).

The reversals of maser behaviour which occur in ruby at low elds on cooling from 80° to 4 °K are explained in terms of crosslaxation transitions (resonant interchanges of energy between ighbouring paramagnetic ions). For an angle of 29° between the agnetic field and the crystal axis a cross-relaxation process was monstrated which involved groups of three ions and had a ansition probability of 700 ± 100 per sec in 0·013% ruby. The ofile of the cross-relaxation resonance had a half-width of 0 ± 30 Mc/s at half-intensity, and had an approximately ussian shape. It should be possible to obtain useful low-field band maser action at 4 °K by pumping ν_{41} with the magnetic field arly perpendicular to the crystal axis, and also at 80 °K using concentration ten times higher, i.e. 0·13%.

19017 CHARACTERISTICS OF AN AMMONIA BEAM MASER. K.Shimoda.

Phys. Soc. Japan, Vol. 16, No. 9, 1728-39 (Sept., 1961).

Describes design, construction and operating characteristics of ammonia beam-type maser, with particular emphasis on the = 3, K = 2 line. The maser with an eight-pole focuser of 40 cm ngth starts oscillation on the 3, 2 line at a focuser voltage of 5.6 kV when the maximum available source flux of about 1.2×10^{18} molecules per sec is used. Threshold conditions of oscillation as functions of the focuser voltage, lengths of the focuser and of the cavity are calculated by the theory of the Maxwell velocity distribution. The frequency-change with cavity tuning and with focuser voltage is compared with theory in some detail. The effect of the travelling wave component in the cavity and the pulling due to cavity tuning are calculated. It is shown that the frequency shift with the focuser voltage becomes very small when the beam flux is reduced.

19018 FREQUENCY DETERMINATION OF THE MASER IN TOKYO (RADIO RESEARCH LABORATORIES) AS COMPARED WITH THE ATOMICHRON (NAVAL RESEARCH LABORATORY). S.Iijima and Y.Saburi.

Publ. Astron. Soc. Japan, Vol. 12, No. 3, 445-7 (1960).

The frequency was determined by comparing radio frequency transmissions having a known frequency deviation from the Atomichron (Cs standard) with the R.R.L. ammonia maser. Over a period of eight months the net standard deviation was ± 2 parts in 10^{10}. The frequency was determined as 23 870 128 809 ±1c/s when compared with the adopted Atomichron frequency of 9 192 631 770 c/s. A.P.C.Thiele

19019 THREE-LEVEL MASER ACTION IN GAS. I. THEORY OF MULTIPLE QUANTUM TRANSITION AND DOPPLER EFFECT IN THREE-LEVEL GAS MASER. T.Yajima.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1594-1604 (Aug., 1961).

The multiple quantum process in the off-resonant condition of the three-level gas maser is discussed. The intensity of the emission produced by this process is calculated by a perturbation theory and also by a more general treatment which is the application of Javan's theory to the off-resonant case (Abstr. 1794 of 1958). Some graphical representations of the signal line under off-resonant pumping are given for the purpose of comparison with experiment. The Doppler effect in the three-level maser action is analysed from both semiclassical and quantum mechanical points of view under the presence of collision relaxation. It is shown that in a saturation process between two levels the Doppler effect contributes to both line-width and relaxation time for the transition, and that under strong pumping, the Doppler effect in the pumping transition has a marked influence on both intensity and shape of the signal line through the effect of multiple quantum transition. See also following abstract.

19020 THREE-LEVEL MASER ACTION IN GAS. II. EXPERIMENTAL STUDY ON FORMIC ACID. T.Yajima.

J. Phys. Soc. Japan, Vol. 16, No. 9, 1709-18 (Sept., 1961).

The quantum mechanical behaviour of the three-level maser was studied experimentally by using the rotational spectrum of the HCOOH molecule at microwave frequencies. By using the $2_{11} \leftarrow 1_{10}$ line at the frequency of 46 581 Mc/s as the pumping, the induced emission of the $2_{11} \rightarrow 2_{12}$ line was obtained at a frequency of 4916 Mc/s. For strong pumping, the splitting of the emission line due to the resonant modulation effect was observed. The line-shape of emission signal under off-resonant pumping was studied in detail. The emission spectrum due to simultaneous emission and absorption of two photons corresponding to the signal and the pumping was observed for the condition of far off-resonant pumping. The results were compared with the theory described in the preceding abstract and were found to be in good agreement in many respects. Some discrepancies concerning emission intensity are also discussed. An application of the multiple quantum transition to a four-level system of HCOOH is described.

19021 THE POSSIBILITY OF APPLYING THE NONLINEAR EFFECT OF RADIOWAVE "SATURATION" FOR ABSOLUTE CAPACITY MEASUREMENTS IN THE MICROWAVE RANGE. V.L.Herman.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 721-7 (1958).
In Ukrainian.

19022 POSSIBILITY OF APPLYING THE NONLINEAR EFFECT OF MICROWAVE SATURATION WITH MAGNETIC RESONANCE TO ABSOLUTE CAPACITY MEASUREMENTS. V.L.Herman.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 6, 845 (1958). In Ukrainian.

19023 MICROWAVE MEASUREMENTS ON A HIGH FREQUENCY GAS DISCHARGE.

G.Lisitano and M.Tutter.
Z. Naturforsch. (Germany), Vol. 16a, No. 7, 692-9 (July, 1961).
In German.

8.7 mm waves were transmitted by means of horns through a discharge tube both along the direction of an applied magnetic field and perpendicular to it. Their amplitudes and phase changes were measured as the high frequency voltage which produced the plasma was varied. For the wave propagated along the magnetic field, measurements were made with the polarisations of the transmitting and receiving horns perpendicular as well as parallel. The electron density and the extent of the plasma, assumed to be a simple cylindrical shape, were calculated for different voltages. C.D.Lustig

MICROWAVE MEASUREMENTS ON A HIGH FREQUENCY GAS DISCHARGE. See Abstr. 19023

19024 LINE SHAPE AND DISPERSION WITHIN THE ABSORPTION BAND WHEN FORCED TRANSITIONS ARE TAKEN INTO ACCOUNT.

S.G.Rautian and I.I.Sobel'man.
Zh. eksper . teor. Fiz. (USSR), Vol. 41, Nos. 2(8), 456-64 (Aug., 1961). In Russian.

Considers the effect of a strong monochromatic electromagnetic field with a frequency close to one of the natural frequencies of the system on the spectral composition of the radiation. The dielectric permitivity of the medium in the presence of the field is computed. [English translation in: Soviet Physics–JETP (USA)].

TRANSMISSION AND REFLECTION OF ELECTROMAGNETIC WAVES AT A PLASMA BOUNDARY FOR ARBITRARY ANGLES OF INCIDENCE. See Abstr. 18865

19025 HIGH-FREQUENCY DIFFRACTION BY A SPHERE.

C.L.Tang.
Canad. J. Phys., Vol. 39, No. 10, 1486-94 (Oct., 1961).

A systematic procedure is given for the determination of the asymptotic series directly from the Helmholtz equation and the boundary conditions for the field in the shadow region of a sphere illuminated by a plane wave at high frequencies. The first two terms in the series for the shadow region, including the regions near the axial caustic and the boundary layer near the surface of the sphere, are explicitly evaluated. The present procedure can be generalized to any smooth convex three-dimensional object with a rotational symmetry, illuminated by a plane wave in the direction of the axis of rotational symmetry.

19026 ON THE THEORY OF THE DIFFRACTION OF A PLANE WAVE BY A LARGE PERFECTLY CONDUCTING CIRCULAR CYLINDER.

P.C.Clemmow.
Proc. Roy. Soc. A (GB), Vol. 264, No. 1317, 235-45 (1961).

The solution is obtained by a method somewhat different from those previously given by other authors. The method is in principle a straightforward application of Fourier integral transform analysis to a boundary-value problem, and is shown to lead rather naturally to the various field representations suitable for different regions, including that at infinity in the forward direction which gives the total scattering cross-section. No new results are obtained in the present paper, but mention is made of other problems which have subsequently been successfully attacked on the basis of the method given.

19027 DIFFRACTION OF A PLANE WAVE BY AN ALMOST CIRCULAR CYLINDER.

P.C.Clemmow and V.H.Weston.
Proc. Roy. Soc. A (GB), Vol. 264, No. 1317, 246-68 (1961).

The two-dimensional problem of an E-polarized plane wave incident on a perfectly conducting cylinder of almost circular cross-section is treated, the maximum deviation of the perimeter of the cross-section from a strict circle being regarded mathematically as an infinitesimal quantity whose second and higher powers are neglected. The method of solution uses infinite Fourier transform techniques, but an analysis involving a Watson transformation, more traditional in this type of problem, is given in an appendix. Attention is for the most part directed to the case in which the mean radius of the cylinder is large compared to the wavelength, and the form of the solution then appropriate is examined in some detail. In particular, initial terms of asymptotic expansions in inverse powers of the mean radius to wavelength ratio are obtained for "specular" and for the "creeping" contributions to the far field. It is shown that the former contribution is in agreement with tha derived by the Luneberg–Kline method, and the latter with the prescription proposed by Keller. Various Bessel function resul are required, some of which are derived in appendices.

19028 ON KOTTLER'S THEORY OF DIFFRACTION.

B.Karczewski.
Acta phys. Polon. (Poland), Vol. 20, No. 5-6, 411-23 (1961).

Kottler's formulation of Huygens's principle for electromag waves (1923) is transformed to give the diffracted amplitude of a component of the electric or magnetic vector as a sum of surfac contour integrals round the diffracting aperture. These integral evaluated by the method of stationary phase and it is shown that result is consistent with the usual Kirchhoff formula for scalar waves. W.T.Wel

THE DIFFRACTION OF A SCALAR WAVE BY A SMALL CIRCULAR APERTURE. See Abstr. 18613

19029 THEORY OF MULTIPLE SCATTERING.

R.Sexl.
Acta phys. Austriaca, Vol. 14, No. 2, 180-4 (1961). In German.

The scattering of a wave from a one-dimensional row of equidistant δ-functions is calculated exactly and the results are compared with Lax's theory of multiple scattering (Abstr. 3289, 5541 of 1952); this theory is found to be inexact. An improved expression for the refractive index of a medium with arbitrarily positioned isotropic point scatterers is derived. J.K.Skwirzy

19030 THE LOW-FREQUENCY SCATTERING BY A PERFECTLY CONDUCTING STRIP.

D.S.Jones and B.Noble.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 2, 364-6 (April, 19

Various authors have derived approximate expressions for t scattering coefficient σ in the diffraction of a plane wave by a narrow perfectly conducting strip. A difficulty connected with th representation of σ as a power series is here pointed out and discussed. P.M.Davic

19031 MICROWAVE ANALOGUE FOR X-RAY DIFFRACTIC II. SIZE OF THE SCATTERERS.

G.S.Sanyal and G.B.Mitra.
Indian J. Phys., Vol. 35, No. 7, 325-32 (July, 1961).

For Pt I see Abstr. 9129 of 1961. The variation, with the azimuthal angle of scattering , of the amplitude of e.m. waves scattered by conducting spheres of sizes (a) comparable and (b) negligible with respect to the wavelength was studied. A wor able theoretical expression is obtained and evaluated by carryin out numerical computations. The theoretical expressions to be computed contain high order Hankel functions, Legendre polynon and their derivatives, numerical values of which are not given in ordinarily available tables. These values are calculated and use in the numerical computations. The resultant curves show that t conducting sphere with $2\pi a/\lambda = 2$, where "a" is the radius of the sphere and λ the wavelength of the e.m. waves is the nearest approximation to several atoms as far as scattering behaviour towards X-rays is concerned.

19032 CALCULATIONS OF MIE BACK-SCATTERING FROM MELTING ICE SPHERES.

B.M.Herman and L.J.Battan.
J. Meteorol. (USA), Vol. 18, No. 4, 468-78 (Aug., 1961).

Calculations of the normalized back-scattering cross-sectio σ_b, of ice spheres surrounded by shells of liquid water were ma from an extension of the Mie theory to a two-layer model. Curv of σ_b as a function of the thickness of the liquid–water shell are presented for various-sized spheres for 3.21, 4.67 and 10.0 cm radiation. It is shown that, depending upon the size of the sphere and the wavelength of the incident radiation, the back-scattering either increase or decrease as the ice acquires a liquid–water shell. For certain-sized spheres, interference phenomena, whic in some instances may lower the value of σ_b by several orders magnitude, are in evidence during the course of melting. Compa ons are made between the theoretical results presented here and experimental measurements of σ_b for melting ice spheres perfo ed by Atlas et al. [Abstr. 425 B of 1961; Quart. J. Roy. Meteorol Soc. (GB), Vol. 86, 468-82 (Oct., 1960)].

19033 THE ABSORPTION OF ELECTROMAGNETIC WAVES, OVER A WIDE FREQUENCY RANGE, BY A THIN MOGENEOUS LOSSY FILM. H.W.Helberg.

angew. Phys. (Germany), Vol. 13, No. 5, 237-45 (May, 1961). erman.

A theoretical analysis is made of the problem of absorbing rgy from electromagnetic waves, with perpendicular incidence, mens of a sheet of dissipative material backed by a metal face. Curves are given enabling the various parameters to be aputed for given cases. As an example, a reflection factor less n 10% was obtained over a range of 3×10^7 to 3×10^8 c/s, ng a ferrite sheet 0.883 cm thick. V.G.Welsby

MICROWAVE ATTENUATION USING A DISCHARGE TUBE. Abstr. 18784

THE ABSORPTIVITY SPECTRUM OF A UNIFORM ANISO-OPIC PLASMA SLAB. See Abstr. 18857

19034 EXPERIMENTS ON THE BENDING OF MICROWAVES BY SURFACE GRIDS. E.M.Amrhein and A.Dietzel.

angew. Phys. (Germany), Vol. 13, No. 5, 245-7 (May, 1961). erman.

The experiments were concerned with the diffraction patterns ained by means of grids formed of matrices of small spheres. e effect on the diffraction patterns of defects in the grid were estigated. V.G.Welsby

19035 ON A SYSTEM OF TWO ARBITRARILY-COUPLED DIPOLES EXCITED BY A PLANE WAVE. P.Szulkin.

l. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 9, -14 (1960). In French.

General differential equations are obtained for the vector ential on the surfaces of two parallel perfectly conducting inders on which a plane wave is incident. From these are derived air of integral equations for the currents in the dipoles.
R.A.Waldron

19036 MICROWAVE TUBES. [MIKROWELLENRÖHREN].

Braunschweig: F. Vieweg (1961) 608 pp.
achrichtentechnische Fachberichte, Vol. 22].

Proceedings of the international congress held in Munich, ne, 1960. Contains 138 articles, in German, French or English, 17 sections: General papers; Klystrons; Travelling-wave tubes; ckward-wave tubes — Type "0"; Amplifiers and backward-wave es — Type "M"; Magnetrons; Tubes of special design; Space-arge waves; Slow-wave structures; Molecular amplifiers; rametric amplifiers; Parametric amplifiers with electron beams; ise; Formation and focusing of electron beams; Gas discharges; n oscillations and Plasma; Technology.

19037 INVESTIGATION OF A HELICAL WAVEGUIDE WITH AN ARTIFICIALLY ANISOTROPIC DIELECTRIC. I.

.B.Fainberh, N.A.Khÿzhnyak, H.A.Sylenok, A.K.Berezin and M.Nekrashevÿch.

rayin. Fiz. Zh. (USSR), Vol. 4, No. 4, 451-9 (1959). In Ukrainian.

A theoretical investigation is made of the retarding properties this waveguide. Anisotropy is achieved by placing the dielectric ng the system in the form of alternating disks. It is known that, the wavelength in the system is large in comparison with the riod of such a structure, an inhomogeneous and isotropic electric acquires the properties of an anisotropic dielectric. nce the thickness of the disks and the distances between them e easily varied, the anisotropy of such a dielectric varies with e specific conditions and may be utilized for controlling other rameters of the waveguide. Expressions for the flow of high-equency power in the inner and outer regions of the helix, the spersion equation of the waveguide, and the specific losses of gh-frequency power in the waveguide (i.e. in the dielectric disks d in the spiral) are obtained and investigated.

19038 INVESTIGATION OF A HELICAL WAVEGUIDE WITH AN ARTIFICIALLY ANISOTROPIC DIELECTRIC. II.

K.Berezin, A.M.Nekrashevÿch, H.A.Silenok, Ya.B.Fainberh and A.Khÿzhnyak.

rayin. Fiz. Zh. (USSR), Vol. 4, No. 4, 460-4 (1959). In Ukrainian.

The results are presented of an experimental investigation of e dispersion properties of this type of waveguide. The artificially isotropic dielectric was formed from polystyrol disks ($\epsilon = 2.5$), being characterized by the following values of dielectric permeability $\epsilon_\perp = 2.34$ and $\epsilon_{\parallel} = 2.16$. Measurements showed that the presence of the disks greatly affects the value of the phase velocity of the waves. The results of measurements on helices with a large pitch, are in good agreement with the predictions of the theory. In the case of dense helices, marked deviations from theory are noted, which may be accounted for by the effect of the finite thickness of the wire on dispersion. Measurements also confirmed the conclusion that anisotropy permits the controlling of the helix properties. It was shown in particular, that with dielectric disks the dispersion may be practically eliminated over a wide range of phase velocities, and it is even possible to pass from normal to anomalous dispersion.

19039 EFFECT OF UNDERGROUND INDUCED POLARIZATION ON E.L.F. PROPAGATION. H.Raemer.

J. geophys. Res. (USA), Vol. 66, No. 5, 1596-7 (May, 1961).

Schumann (Abstr. 7206 of 1958) and Wait's (Abstr. 12715 of 1960) theory is used to show that such polarization has a negligible effect on the frequencies of resonant modes in the earth—air—ionosphere cavity for frequencies below 1 kc/s. J.M.Hough

19040 THE BOUNDARY PROBLEM FOR THE PROPAGATION OF ELECTROMAGNETIC WAVES IN A SPHERICALLY-LAYERED, ANISOTROPIC, DISSIPATIVE MEDIUM.

P.E.Krasnushkin.

Dokl. Akad. Nauk SSSR, Vol. 138, No. 4, 813-16 (June 1, 1961). In Russian.

For abstract, see Abstr. 16578 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 6, 466-9 (Dec., 1961)].

19041 THE SPECTRUM AND THE TOTAL INTENSITY OF ELECTROMAGNETIC WAVES SCATTERED FROM AN IONIZED GAS IN THERMAL EQUILIBRIUM IN THE PRESENCE OF A STATIC QUASI-UNIFORM MAGNETIC FIELD.

J.Renau, H.Camnitz and W.Flood.

J. geophys. Res. (USA), Vol. 66, No. 9, 2703-32 (Sept., 1961).

The spectrum of electromagnetic waves scattered from thermal electron density fluctuations in an ionized gas in the presence of a static, quasi-uniform, magnetic field was derived through the use of the Nyquist noise theorem. General analytical results of the spectrum are given and graphs presented for the special case of backscattering.

19042 REFLECTION OF ELECTROMAGNETIC WAVES IN GYROTROPIC MEDIA FROM A MAGNETIC FIELD WAVE. G.I.Freidman.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 226-33 (July, 1961). In Russian.

The reflection of electromagnetic waves in a ferrite or in an infinite homogeneous plasma from the wave of a magnetic field (moving magnetic "mirror") and also the reflection from a moving plasma and from an ionization wave produced in a stationary plasma are considered. The calculations are performed in the geometrical optics approximation. A more exact solution is found in the neighbourhood of the point at which the approximation becomes invalid. It is shown that in all the cases considered, the frequency increases upon reflection. The wave amplitude and total energy of the wave packet also increase after reflection; an exception is reflection from an ionization wave, for which the amplitude of the reflected wave is equal to the amplitude of the incident wave and the total energy of the wave packet decreases upon reflection. [English translation in: Soviet Physics—JETP (USA)].

19043 DAILY AND SEASONAL VARIATIONS OF THE FIELD INTENSITY OF LONG RADIO WAVES.

P.E.Krasnushkin.

Dokl. Akad. Nauk SSSR, Vol. 140, No. 4, 783-6 (Oct. 1, 1961). In Russian.

New ionization charts are provided for the northern hemisphere for seasonal variation (in winter, spring and summer) of height, ionization density and characteristic frequency of the layers. These are compared with intensity data of stations as recorded in England, USA and USSR over one cycle of the sun-spot variation. [English translation in: Soviet Physics—Doklady (USA)].
J.K.Skwirzynski

19044 PREDICTION OF V.L.F. DIURNAL PHASE CHANGES AND SOLAR FLARE EFFECTS. W.D.Westfall.
J. geophys. Res. (USA), Vol. 66, No. 9, 2733-6 (Sept., 1961).

VLF diurnal phase shift data are compared with predictions resulting from the waveguide equations for the first order mode. The effects of higher order mode energies appear to exist out to 2700 km, and may at times affect measurements beyond this range. A relation is given for the prediction of diurnal phase shift for 10-20 kc/s radio waves. Expressions are given for relating observed VLF phase perturbations caused by both small and large solar flares to the resulting apparent decreases in ionospheric reflecting height.

19045 V.L.F. IONOSPHERIC REFLECTION COEFFICIENTS — DERIVATION FROM IMPEDANCE CONCEPTS AND VALUES FOR SOME MODEL IONOSPHERES.
E.C.Field and P.Tamarkin.
J. geophys. Res. (USA), Vol. 66, No. 9, 2737-50 (Sept., 1960).

A convenient general method is presented for computing the reflected wave excited by an arbitrarily polarized, plane, VLF e.m. wave incident at an arbitrary direction upon a sharply bounded, absorptive ionosphere in the geomagnetic field. The relative simplicity of the method results from the use of impedance concepts coupled with Booker's (1938) treatment of the propagation vector. Expressions for reflection coefficients are given that are exact (for the model assumed) in the case of propagation perpendicular to magnetic meridians and indicate clearly lack of east—west and west—east reciprocity. The results of calculations for eight model ionospheres are given in the form of graphs of reflection coefficient amplitude and phase versus angle of incidence for both east—west and west—east propagation at 16 kc/s. The model ionospheres are characterized by values of electron density and collision frequency. A brief survey is made of the relation between the computations and some experimental results.

TRANSATLANTIC COMMUNICATION EXPERIMENT VIA ECHO I SATELLITE. See Abstr. 18233

Radiofrequency Spectroscopy Techniques

19046 FROM RADAR TO SPECTROSCOPY: NEW REGIONS OF THE SPECTRUM. D.J.E.Ingram.
Nature (GB), Vol. 191, 1146-7 (Sept. 16, 1961).

The Kelvin lecture to the British Association. A popular review of radio frequency and microwave spectroscopy, with mention of the 21 cm radiation of hydrogen, the Cs clock, the use of electron spin resonance for detecting free radicals and the maser.

G.F.Lothian

19047 MAGNETIC SPECTRUM ANALYSERS.
E.K.Zavoiskii and V.A.Skoryupin.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 426-32 (Feb., 1961). In Russian.

The possibility of using paramagnetic and other magnetic resonance effects for studying radiation spectra is investigated. The attenuation in helical and coaxial lines, sensitivity, saturation, and the limiting spectrum recording speed are calculated. Descriptions are given of magnetic spectrum analysers (MSA) of t following types: (1) frequency-compensated MSA; (2) "resonanc" MSA; (3) induced-radiation MSA; (4) induction MSA. The experimental results obtained with a frequency-compensated analyser re reported; an oscillogram obtained at 3 cm with an MSA filled wi the paramagnet $MnSO_4$ and an oscillogram showing the spectrum f an oscillatory spark circuit are also presented. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 292-6 (Aug., 1961)].

19048 PARAMAGNETIC RESONANCE APPLIED TO MOLECULAR AMPLIFICATION.
P.Jung, J.Van Cakenberghe and J.Uebersfeld.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 355-60 (1960
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The component of the magnetization in the direction of the constant magnetic field, H_Z, was varied by applying an r.f. field parallel to H_Z and a microwave field perpendicular to H_Z. A negative susceptibility, with the possibility of amplification, was observe when the resonance field was larger than H_Z. Results of theoret treatment are presented. The theory was tested by a 3 cm wavele and at 3 Mc/s with a microwave cavity containing a r.f. coil with 0.16 g of DPPH. The microwave power is 5 W.

F.B

19049 NUCLEAR MAGNETIC RESONANCE PARASITIC LI PRODUCED BY MODULATION OF THE STATIC FIE
H.Ottavi.
C.R. Acad. Sci. (France), Vol. 253, No. 3, 430-2 (July, 1961).
In French.

19050 EXPERIMENTAL ARRANGEMENTS FOR THE MEAS MENT OF PARAMAGNETIC RELAXATION AND RESONANCE, AND OF NUCLEAR MAGNETIC RESONANCE IN T LOUVAIN LABORATORY FOR LOW TEMPERATURES.
III. NUCLEAR PARAMAGNETIC RESONANCE.
L. van Gerven, A. van Itterbeek and L.Stals.
Meded. K. Vlaamse Acad. Wetensch. (Belgium), Vol. 22, No. 2, 44 pp.(1960). In Flemish.

For Pt II, see Abstr. 8132 of 1958. In a theoretical introduct using the theory of Bloch, a comparison is made between nuclear paramagnetic resonance (n.m.r) and electron paramagnetic reson ance (e.p.r.). The special properties and shapes of the n.m.r. lin are explained in a simple manner. The most important parts of n.m.r. apparatus in the Louvain Laboratory are described: magn power supply, and h.f. oscillator. The results of a study and calibration of the magnetic field of an Oerlikon electromagnetic, n.m.r. and e.p.r., are given.

19051 A NUCLEAR RESONANCE SPECTROMETER FOR BROAD LINES. E.Kleimon and G.Klee.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 1, No. 7-10, 463-7 (1959). In German.

A brief description and block diagram is given of a nuclear magnetic resonance spectrometer operating on the autodyne dete principle and using a Hopkins type oscillator. The apparatus is s able for the recording of broad lines in solids and high viscosity liquids.

P.M.Par

NUCLEAR MAGNETIC RESONANCE PROBE FOR ALIGNING ELECTROMAGNETS. See Abstr. 16478

NUCLEAR PHYSICS

9052 RUTHERFORD JUBILEE INTERNATIONAL CONFERENCE — MANCHESTER, SEPTEMBER 1961.
.Burcham.
t. J. appl. Phys., Vol. 12, No. 12, 641-5 (Dec., 1961).

See Abstr. 16610 of 1961. Report on a conference sponsored by The ernational Union of Pure and Applied Physics, The Royal iety, The Institute of Physics and The Physical Society, and Victoria University of Manchester, was held at Manchester ween the 4th and 8th of September 1961, in recognition of the ilee of the discovery of the atomic nucleus by Rutherford. This se directly from the experiments of Geiger and Marsden in herford's laboratory at Manchester. Under the presidency of Ernest Marsden a wide range of topics in experimental and oretical nuclear physics was covered by a number of invited akers. A special commemorative session was included in the ceedings.

APPARATUS

PARTICLE DETECTORS

(Counting circuits are included under Electrical Measurements and Circuits)

19053 ON THE MECHANISM OF MULTIPLE DISCHARGES IN HALOGEN-QUENCHED G.M. COUNTERS. O.J.Orient.
clear Instrum. and Methods (Internat.), Vol. 9, No. 2, 165-71 ov., 1960).

Multiple discharges taking place during the excitation section counting tubes filled with neon gas up to 200 mm Hg and bromine to 0.5 mm Hg pressure were investigated. The amplitude and distribution in time of multiple discharges were examined with oscillo-synchroscope. Multiple discharges occur after dead time, ir amplitudes being always smaller than the main pulse. Their mber diminishes and their amplitude increases with time. In the citation section multiple discharges were separated with a threshld discriminator. Performances examined with this method show excitation section. This confirms the observation that the excitan section is due to multiple discharges of amplitudes smaller an the main discharge. For the distribution in time of multiple scharges, the evaluation of the measurements resulted in an exnential relationship. The value obtained for the constant term aking part of the exponent was found to be identical with the decay nstant of metastable neon atoms. This confirms the assumption at multiple discharges are originated by u.v. photons resulting om the decay of metastable neon atoms produced around the filaent in the main discharge. By using the exponential time distribuon of multiple discharges as obtained in measurements, the probility of multiple discharges originating from metastable disintepation is calculated.

19054 A THREE-CHANNEL LOW-BACKGROUND COUNTING UNIT. D.Rowan and W.Stevenson.
ternat. J. appl. Radiation and Isotopes (GB), Vol. 9, No. 1-4, 0-2 (Dec., 1960).

Low-background counters based on anti-coincidence circuits e in general use for the assay of low activity β-emitting samples. e unit described was designed and built for measurements the range 1-10 counts/min on Sr^{90} and Y^{90} samples. It has the llowing features: (a) three channel operation without interaction,) continuous operation without adjustment of controls, and (c) se of sample presentation.

19055 EVIDENCE OF PULSES PRODUCED BY ALPHA-PARTICLES IN AN IONIZATION CHAMBER FILLED TH HEXANE LIQUID, AT LABORATORY TEMPERATURE.
.Blanc and J.Mathieu.
. Phys. Radium (France), Vol. 21, No. 8-9, 675-6 (Aug.-Sept., 61). In French.

The alpha source (Po^{210}) was deposited on the interval face one of the electrodes of the ionization chamber. The variation of the pulse height of the pulses obtained from the alpha-particles is plotted as a function of the strength of the electric field in the chamber. Fields of up to about 70 000 V cm^{-1} were used in the experiment. In hexane the alpha-particles would produce about 3.8×10^5 ion pairs which would produce a pulse of height about 30×10^{-5} V. The fact that, for field strengths of above about 55 000 V cm^{-1}, greater pulse heights were obtained confirmed the existence of ion multiplication in the liquid hexane.

C.F.Barnaby

19056 THE EFFECT OF LIQUID VAPOURS ON THE OPERATION OF AIR SPARK COUNTERS. I. B.Sujak.
Acta phys. Polon. (Poland), Vol. 20, No. 5-6, 493-505 (1961).
In German.

A large number of organic liquids were used and a study made of the pulse spectra as a function of time. R.H.Thomas

19057 FORM OF THE SENSITIVE VOLUME OF SPARK COUNTERS (WIRE-PLANE). D.Blanc and P.Laborie.
C.R. Acad. Sci. (France), Vol. 253, No. 17, 1786-8 (Oct. 23, 1961).
In French.

The sensitivity of a counter with a wire irradiated frontally (α-particles) is a maximum in the plane of symmetry containing the wire; under lateral irradiation, the maximum is adjacent to the plate. It is likewise for several parallel wires; if their spacing δ is much greater than their distance d from the plane, if $\delta \leq d$, the maximum for lateral irradiation is nearer to the wire, especially when δ is very small. B.Brown

19058 CHARACTERISTICS OF SCINTILLATION COUNTERS. T.Radoszewski.
Nukleonika (Poland), Vol. 5, No. 6, 361-8 (1960). In Polish.

Anode voltage characteristics and discriminator bias curves were investigated using EMI 9514 S and 9524 B photomultiplier tubes with NaI(Tl) and plastic scintillators for a range of β- and γ-ray energies. The significance of plateaus is discussed and a method is given for choosing the optimum working conditions of a scintillation counter. S.Swierszczewski

19059 THE PILE-UP OF PULSES AND ITS INFLUENCE ON ENERGY SPECTRA. P.Moatti.
J. Phys. Radium (France), Vol. 22, Suppl. No. 2, 71A-72A (Feb., 1961). In French.

A formula for calculating the correction for the pile-up of pulses (the superimposition of pulses which arrive within the resolution time of the instrument) is given. The theory is verified experimentally by using a NaI scintillation counter to obtain the γ-spectrum of Au^{198}. C.F.Barnaby

19060 SCINTILLATION DETECTOR OF 4m^2 AREA AND TRANSISTORIZED AMPLIFIER WITH LOGARITHMIC RESPONSE. K.Suga, G.Clark and I.Escobar.
Rev. sci. Instrum. (USA), Vol. 32, No. 11, 1187-9 (Nov., 1961).

A scintillation detector with an area of 4m^2 and a transistorized amplifier with a logarithmic height-to-time convertor are described. The detector employs tapered sheets of plastic scintillator and a single 16 in. photomultiplier mounted in a pyramidal can, coated inside with a commercial 90% reflecting white paint. The response is uniform to within 5% over the entire sensitive surface. A traversal by one relativistic charged particle (energy loss ~ 10 MeV) generates approximately 20 photoelectrons in the photomultiplier. The amplifier and convertor yield a rectangular pulse with a duration accurately proportional to the logarithm of the input pulse amplitude over a range of four decades. The gain is constant to 1 dB from 10° to 45°C, and the equivalent noise imput is 200 μV.

19061 A NOTE ON THE BACKGROUND IN NaI SCINTILLATION COUNTERS. S.Raboy and C.C.Traul.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 145-8 (Nov., 1960).

The residual background in sodium iodide (thallium activated) crystals was studied with the scintillation spectrometer with an anticoincidence annulus. The characteristic response of this system to γ-rays was used to identify background peaks as coming from γ-rays and not-charged particles. There were contributions from the natural radioactivity of K^{40}, the Th^{232} series, and the U^{238} series. By controlled experiments it was concluded that the decays from K^{40} and the U^{238} series originate in the room surroundings and that the activity from the Th^{232} series originates in the immediate vicinity of the sodium iodide crystal, such as the materials of the package. The results are consistent with the assumption of no radioactive contaminant within the crystal itself.

19062 PULSE SHAPE DISCRIMINATION AND ENERGY RESPONSE OF CALCIUM TUNGSTATE CRYSTALS.

W.R.Dixon and J.H.Aitken.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 229-32 (Nov., 1960).

The scintillation response of calcium tungstate crystals to gamma-rays, protons and alpha-particles was studied. It is shown that there is a difference in shape between gamma-ray and alpha-particle pulses, and that this effect may be exploited to discriminate between particles.

19063 THE MEASUREMENT OF PROTON BEAMS WITH PHOTOSEMICONDUCTORS AND THE MEASUREMENT OF THE POLARIZATION RELATIONSHIP IN CERTAIN PHOTOCATHODES. P.Görlich.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 2, 67-70 (1960). In German.

The sensitivities of various detectors used with a Tl-activated CsI crystal as scintillator are compared. The sensitivities of the semiconductors, "selenium photoelement type F" and CdS, are also compared. It was found that emission from Cs_3Sb photocathodes was greatest when the electric vector of the incident light lay in the plane of the cathode surface. A.J.Fox

A UNIVERSAL METHOD FOR STABILIZING SCINTILLATION SPECTROMETER SYSTEMS. See Abstr. 18734

19064 A THREE CRYSTAL PAIR SPECTROMETER.

L.Ask, B.Erlandsson, B.Persson and K.Valli.
Ark. Fys. (Sweden), Vol. 19, Paper 3, 21-32 (1961).

The construction of a scintillation pair spectrometer of high efficiency and good energy resolution is described. Its response function for energies below 18 MeV is obtained and the variation of this response, due to different collimations of incident radiation and the use of central crystals of different lengths, is studied.

19065 CONTRIBUTION TO THE STUDY OF THE VARIATION OF THE GAIN OF PHOTOMULTIPLIERS AS A FUNCTION OF THE COUNTING RATE OF PULSES. R.Chéry.

J. Phys. Radium (France), Vol. 21, No. 8-9, 679-80 (Aug.-Sept., 1960). In French.

Experimental results clearly showing the variation of the gain of a type 53 AVP photomultiplier used with a NaI crystal, as a function of counting rate, are presented. The effect is discussed in some detail and methods of stabilizing the gain are suggested. C.F.Barnaby

19066 QUANTUM COUNTERS.

A.M.Prokhorov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1384-6 (May, 1961). In Russian.

Noise in solid-state quantum counters (Abstr. 6281 of 1959) is examined and the transient time in the counters is estimated. [English translation in: Soviet—Physics—JETP (USA)].

19067 REMARKS ON PROTECTION SURVEY BY FILM DOSIMETERS IN THE GERMAN DEMOCRATIC REPUBLIC.

W.Kiesewetter.
Isotopentechnik (Germany), Vol. 1, No. 3, 82-5 (Jan., 1961). In German.

Discussion about ways and means for dosimetric monitoring the personnel radiation loading by β-, γ-, and X-rays as well as by neutrons by means of film dosimeters. Particular attention is given to the constitution of an appropriate monitoring service.

19068 THE CALIBRATION OF BETA DOSE-MEASUREMENT DEVICES. W.Burkhardt and D.Herrmann.

Atomkernenergie (Germany), Vol. 5, No. 9, 324-32 (Sept., 1960). In German.

For various pure β-ray emitters, the dose distribution around point sources in homogeneous materials is calculated according to a theory of Spencer. A short survey is given of the methods of absolute measurement of beta-ray doses. A special method is described in which a "wall-less" ionization chamber i achieved by measurements with various wall-thicknesses and extrapolation to zero wall-thickness. This method is used for calibration of β-sensitive pocket ionization chambers, for absolu measurement of the point source dose functions of W^{185}, Tl^{204}, an P^{32}, and for determination of the absolute activity of point source of pure β-ray emitters.

19069 THE PRODUCTION OF AIR-EQUIVALENT MATERIA. W.Dedek and C.F.Weiss.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 1, No. 7-10, 404-8 (1959). In German.

Discusses the problems involved in producing air-equivalent substances for dose-rate measurements. R.H.Thom

19070 NEW GLASS IS EXCELLENT HIGH-LEVEL DOSIMETER.

Nucleonics (USA), Vol. 19, No. 9, 88 (Sept., 1961).

Si 104 glass [52 wt.% Bi_2O_3, 24 wt.% B_2O_3, 17 wt.% PbO, 4.5 wt.% SiO_2, 2.4 wt.% As_2O_3] on exposure to radiation shows an increase in optical absorption in a band centred at 515 mμ. The glass can be used as a dosimeter, with a range from 10^5r to 10^9r, which is nearly free from fading. R.D.Sm

19071 STATISTICAL ERRORS IN DISINTEGRATION RATE MEASUREMENTS BY THE COINCIDENCE TECHNIQU

P.J.Campion and J.G.V.Taylor.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 2-3, 131-3 (April, 1961).

Derives an expression for the standard deviation in the numb of disintegrations measured by coincidence counting techniques. The variation of standard deviation with efficiency of each detecto is obtained. R.H.Thom

19072 SMALL SCATTERING CHAMBER FOR LARGE ANGULAR REGION.

H.R.E.Tjin A Djie, F.J. de Heer and L.A.C.Koerts.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 172-4 (Nov., 1960).

A description is given of a small vacuum chamber for scattering of charged particles on nuclei at low and intermediate energie (< 30 MeV). The chamber has an angular range of 0° to 160° and can be used without foils in front of the counters.

Track Visualization

19073 A HIGH-PRESSURE DIFFUSION CHAMBER IN A PUL MAGNETIC FIELD. M.S.Kozodaev, M.M.Kuliukin, R.M.Suliaev, A.I.Filippov and Yu.A.Shcherbakov.

Pribory i Tekh. Eksper. (USSR), 1958, No. 6, 47-55 (Nov.-Dec.). In Russian.

An installation with a high-pressure diffusion chamber, intended for working with particle beams from a synchrocyclotro is described. The diameter of the working area of the chamber i 300 mm, the external diameter is 456 mm. The chamber is desig for operation with H_2, D_2 and He at a pressure of up to 25 atm. T magnetic field in the sensitive volume reaches a value of 11 200 O in continuous operation and 16 000 Oe in pulse operation. A description is also given of an auxiliary apparatus intended for controlling and checking the operation of the installation. [Englis translation in: Instrum. exper. Tech. (USA), No. 6, 760-9 (Nov.-Dec., 1958; publ. Oct., 1959)].

19074 IONIZATION MEASUREMENT IN A WILSON CHAMBE BY A PHOTOMETRIC METHOD. S.V.Riabikov.

Pribory i Tekh. Eksper. (USSR), 1958, No. 6, 56-60 (Nov.-Dec.). In Russian.

A photometric method of determining the ionization created b particles in the gas of a Wilson chamber is described. The track consisted of unresolved images of drops on a film. A calibration curve which expresses the connection between the relative blackening on the film and the ionization was plotted. The masses several particles were determined by way of an example. The error in the determination of ionization is 16-20%. [English

slation in: Instrum. exper. Tech. (USA), No. 6, 771-5 (Nov.-
., 1958; publ. Oct., 1959)].

19075 A RAPID CYCLING BUBBLE CHAMBER.
L.Bertanza, P.Franzini, I.Mannelli and G.V.Silvestrini.
lear Instrum. and Methods (Internat.), Vol. 9, No. 3, 354-6
c., 1960).
Describes the design and operation of a 1.12 l propane—ethane
bubble chamber, operated at room temperature with a repeti-
rate of 4-5 expansions per sec. The chamber has worked with
d stability for several periods of 20-40 hr.

19076 THE AUTOMATIC COLLECTION AND REDUCTION OF DATA FOR NUCLEAR SPARK CHAMBERS.
elernter.
vo Cimento (Italy), Vol. 22, No. 3, 631-42 (Nov. 1, 1961).
A system is described which dispenses with the traditional use
hotographic film for recording the data contained in the discharge
nuclear spark chamber. Instead, the chamber itself is
ectly viewed by a television vidicon camera, whose output is
itized for direct input to a computer or for recording on
gnetic tape. Preliminary experiments indicate that a measure-
nt precision of 0.1% (i.e., to locate the centre of a spark to 1 mm
metre-wide chamber) will be easy to achieve with ordinary
ustrial vidicon tubes. The existence of currently available high
solution vidicons makes it likely that this figure can be substan-
lly improved. By coupling the video system directly to an
M 7090 computer, it is shown that the automatic collection and
-line analysis of 100 000 spark chamber events per day is
bably feasible.

19077 DARKENING OF PHOTOGRAPHIC PLATES BY VARIOUS HEAVY CARBON MOLECULAR IONS.
örnenburg and H.Hintenberger.
Naturforsch. (Germany), Vol. 16a, No. 7, 676-85 (July, 1961).
German.
The darkening of an Ilford Q2 plate as a function of the number
incident particles was determined in a mass spectrograph for
rbon molecular ions up to C_{26}^{+}. In addition to the experimental
ails, methods for obtaining the darkening curve of the photographic
te, the use of the standard curve in determining isotopic content of
nown mixtures, and the mass dependence and absolute sensitivity
the photographic plate are also discussed. C.R.Ward

19078 STUDY OF THE ACTION OF TEMPERATURES BETWEEN 20° AND 110°C ON THE SENSITIVITY OF
CLEAR EMULSIONS TO DIFFERENT RADIATIONS.
echenmann.
n. Phys. (France), Vol. 6, No. 7-8, 1001-51 (July-Aug., 1961).
French.
Reports a systematic study of the behaviour of Ilford C2 and K5
lear emulsion exposed at elevated temperatures. There is
dence that the raised temperature produces a partial coagulation
the sensitive centres produced during an exposure of G5 emulsion
light or to ionizing radiation. This redistribution manifests itself
variation in the sensitivity of the emulsion with the nature and
e of developer used. The sensitivity of C2 emulsion is affected in
imilar manner. S.J.St-Lorant

19079 THE ACTION OF THE INTERNAL CENTRES OF SENSITIVITY IN NUCLEAR EMULSIONS.
eneš and J.Kubal.
ech. J. Phys., Vol. 10, No. 8, 612-13 (1960). In German.
An attempt is made to demonstrate experimentally that the
duction of an image by a charged particle is a volume process,
ing place inside a grain of photographic emulsion whereas the
tion of light is purely a surface phenomenon. The action of
ethanolamine is discussed within this context. S.J.St-Lorant

19080 DILUTION OF NIKFI-R EMULSIONS WITH GELATIN. T.A.Romanova.
ibory i Tekh. Eksper. (USSR), 1958, No. 4, 93-5 (July-Aug.).
Russian.
The possible application is demonstrated of 2-2.5 times
uted NIKFI-R emulsions to relativistic particle recording. The
lization of diluted emulsions with the silver halide volume
tent decreased by 8 or more times (depending on the particle
rgy) is of some interest in low-energy particle recording.
[English translation in: Instrum. exper. Tech. (USA), No. 4, 559-61 (July-Aug., 1958; publ. June, 1959)].

19081 A METHOD OF IDENTIFYING CHARGED PARTICLES.
B.Forkman and S.A.E.Johansson.
Ark. Fys. (Sweden), Vol. 19, Paper 8, 99-107 (1961).

The method consists of a combination of a magnetic field and nuclear emulsions. The orientation and length of the tracks in the emulsions are measured and the trajectories of the particles in the magnetic field are calculated, assuming them to be protons, deuterons, or α-particles. The intersection point relative to the position of the target in the various cases makes it possible to identify the particles. The method was used successfully in an investigation of the charged particles emitted in photonuclear reactions.

SLIDE RULE TO WORK OUT NUCLEAR PARTICLES TRACK LENGTHS. See Abstr. 17983

NUCLEAR FIELD THEORY

19082 DISPERSION RELATIONS AND THE ABSTRACT APPROACH TO FIELD THEORY. Edited by L.Klein.
New York: Gordon and Breach (1961) x+273 pp. (International Science Review Series, Vol. 1).

The aim of the book is to provide an introduction to a new and rapidly expanding field. It consists of reprints of papers chosen by the editor. In an attempt to present a coherent picture, basic papers as well as more recent advances are included. For abstracts of the papers presented see, in the following order: Abstr. 5288 of 1954; 1510 of 1955; 8376 of 1957; 901 of 1956; 5864 of 1955; 2158 of 1958; 2038 of 1959; 2766 of 1958; 38 of 1958; 5654 of 1958; 2079 of 1959; 4941 of 1959; 8219 of 1958; 448 of 1961. The volume concludes with a review article by Gasiorowicz [Fortschr. Phys. Vol. 8, 665-726 (1960)].

SOLUBLE MODEL IN QUANTUM FIELD THEORY: THE WENTZEL MODEL. See Abstr. 18259

19083 ON THE FERMION MASS PROBLEM IN THE γ^5 INVARIANT MODEL OF QUANTUM FIELD THEORY.
B.A.Arbuzov, A.N.Tavkhelidze and R.N.Faustov.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 2, 345-7 (July 11, 1961).
In Russian.

For abstract, see Abstr. 16639 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 7, 598-9 (Jan., 1962)].

19084 UNCERTAIN SPACE-TIME CONTINUUM, UNCERTAIN MASS AND PAULI—VILLARS REGULARIZATION.
G.Heber.
Nuovo Cimento (Italy), Vol. 21, No. 6, 1045-57 (Sept. 16, 1961).
In German.

It is shown that the field equations for a non-localizable, scalar field of mass zero (Abstr. 9192 of 1959) have solutions, amongst many others, the Green's functions of which are identical with the regularized functions of Pauli and Villars (Abstr. 47 of 1950). The compensating masses, however, have a physical meaning, insofar as they correspond to the different possible masses of one particle with uncertain mass. The result of this work is that it should be possible to create a convergent field-theory by introducing into the theory an uncertain mass (inside a very small interval) of the field-particle, or uncertain positions of the test-bodies, measuring the field.

19085 SOME PROPERTIES OF DRESSED PARTICLE OPERATORS IN FIELD THEORY.
M.A.Braun and Yu.V.Novozhilov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1317-22 (Nov., 1960). In Russian.

The authors investigate the properties of dressed particle operators, defined as producing single particle states when acting on a vacuum. Haag (Abstr. 2044 of 1959) has shown that the dressed-particle creation operators have a strong-convergence limit for infinite time. It is shown that this is also true for the annihilation operators. Assuming the possibility of a coupling-constant expansion, the authors show that the dressed operators cannot satisfy the causality condition in its usual form. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 919-22 (May, 1961)].

19086 A MODEL OF LOCAL FIELD THEORY WITH FINITE CHARGE RENORMALIZATION.

B.M.Barbashov and G.V.Efimov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 848-59 (March, 1961).
In Russian.

The local field theory proposed by Bialynicki-Birula (Abstr. 11801 of 1959) is treated by a previously developed method (Abstr. 5505, 20015 of 1960). The S-matrix and renormalization constants are derived. It is proved that the charge renormalization is finite in all orders and does not contain logarithmic singularities. It is shown that the ultraviolet contribution results in a series with a finite sum, and that the Green's function series converges absolutely at low values of the time and has a branch point at $t = 0$, the singularity at zero being integrable. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 595-602 (Sept., 1961)].

19087 THE ASYMPTOTIC BEHAVIOUR OF GREEN'S FUNCTIONS IN QUANTUM FIELD THEORY.

V.P.Gachok.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 879-83 (March, 1961).
In Russian.

The formalism of vacuum expectation values of products of field operators is used to prove for quantum field theory a principle of the weakening of correlations analogous to the corresponding Bogolyubov principle in quantum statistics. By the extension of these results to the Green's functions, a proof is obtained for the hypothesis of Freese (Abstr. 5269 of 1954) about the asymptotic behaviour of Green's functions at large space separations. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 616-19 (Sept., 1961)].

19088 THE CAUSALITY CONDITIONS IN QUANTUM THEORY. V.Ya.Fainberg.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1758-67 (June, 1961).
In Russian.

It is shown that the Bogolyubov causality condition and the condition of local commutativity of the interacting field operators $\varphi(x)$ yield the same expressions for the S matrix elements on the mass shell. The necessary and sufficient conditions of local solvability of the equation for the Heisenberg operators $\varphi(x)$ are derived under the assumptions that the current commutator $[j(x), j(y)]$ vanishes outside the light cone, that is, the so-called Wightman problem is solved. [English translation in: Soviet Physics—JETP (USA)].

19089 A RELATIVISTIC FIELD THEORY MODEL WHICH ADMITS AN EXACT SOLUTION.

D.A.Kirzhnits and S.A.Smolyanskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 205-8 (July, 1961).
In Russian.

A model which is a relativistic extension of the Ruijgrok—van Hove (Abstr. 8377 of 1957) and Lee model and which does not involve the difficulties inherent in the latter is examined. [English translation in: Soviet Physics—JETP (USA)].

19090 A GAUGE INVARIANT FORMULATION OF NEUTRAL VECTOR FIELD THEORY.

V.I.Ogievetskii and I.V.Polubarinov.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 247-55 (July, 1961).
In Russian.

It is demonstrated that zero mass neutral vector field theory can be formulated in a gauge invariant form without the introduction of auxiliary fields. The physical meaning of gauge invariance in such a theory is trivial: the zero spin quanta described by the 4-vector A_μ do not interact with anything. Only quanta with a spin 1 can interact. [English translation in: Soviet Physics—JETP (USA)].

QUANTIZATION OF PHYSICAL SPACE-TIME OPERATORS. See Abstr. 18279

19091 THE THIRRING MODEL.

F.A.Berezin.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 885-94 (March, 1961).
In Russian.

The four-fermion Thirring model is considered and the field operators are determined by functional quadrature. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 620-5 Sept., 1961)].

19092 FIELD METRICS. III. FIELD CHARGES:

P.Sen.
Nuovo Cimento (Italy), Vol. 21, No. 5, 710-15 (Sept. 1, 1961).

For Pt II (see Abstr. 15224 of 1960; 7183 of 1961). The determinants of the field metrics, defined earlier by correlatio with the field wave equations, are evaluated and found to be products of the strengths of the field charges. It is suggested t these determinants have the value unity in the natural field units and the resulting correlation with the principles of relativity ar considered. It is shown that in general the strengths of all field charges can then be determined. The procedure is illustrated i detail for the Tanikawa field theory and the values obtained for field charges are found to support it.

19093 ASYMPTOTIC CONDITION IN THE LORENTZ GAUGE. M.Wellner.

Nuovo Cimento (Italy), Vol. 21, No. 5, 867-8 (Sept. 1, 1961).

It has been pointed out by Evans and Fulton (Abstr. 4761 of that the LSZ asymptotic condition is formally incompatible with quantum electrodynamics in the Lorentz gauge. The present not suggests a modification of the asymptotic condition which restor the compatibility. T.E

19094 BEHAVIOUR OF THE CROSS-SECTION OF ELECTR- MAGNETIC PRODUCTION OF PARTICLES AT THE THRESHOLD. V.N.Baier and S.A.Kheifets.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 716-17 (Feb., 1961)
In Russian.

In the conversion of an $e^+ - e^-$ pair into a heavier fermion-antifermion pair, radiative corrections do not compensate for the effect of photon emission as they do for $e^+ + e^- \rightarrow e^+ + e^-$. Thi gives, in the case of muons near threshold, $d\sigma \sim q^{1.1}$ instead of $d\sigma \sim q$, where q is the momentum. [English translation in: Sovie Physics—JETP (USA), Vol. 13, No. 2, 500-1 (Aug., 1961)].

J.E.Pa

19095 THE ASYMPTOTIC FORM OF THE VERTEX PART I ELECTRODYNAMICS. V.G.Vaks.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1366-8 (May, 1961).
In Russian.

The quantum-electrodynamic vertex part is found for a certa momentum range. [English translation in: Soviet Physics—JET (USA)].

19096 BRANCHING OF THE ELECTRON AND PHOTON GREEN'S FUNCTIONS. V.G.Vaks.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1725-7 (June, 1961).
In Russian.

Branching of the electron Green's function G(p) and the photo function D(k) is examined respectively at the points $p^2 = m^2$ and $k^2 = 0$. In electrodynamics, branching of G(p) indicates a non-stationary behaviour of the amplitude of a single-electron state. For the usual gauging of the potentials, this amplitude increases with time, this being connected with the indefinite metrics. Branc ing of D(k) for $k^2 = 0$ arises as a result of weak three-photon and photon—neutrino interactions. However, the singularity of the function at this point is weak and the single-photon state therefore remains stationary. [English translation in: Soviet Physics—JET (USA)].

GAUGE COVARIANCE OF SPINOR GEOMETRY. See Abstr. 18266

19097 TENSOR OPERATOR FOR ELECTRON POLARIZATI

D.M.Fradkin and R.H.Good, Jr.
Nuovo Cimento (Italy), Vol. 22, No. 3, 643-9 (Nov. 1, 1961).

It is shown that the polarization of a free Dirac particle can b treated in a covariant way in terms of an antisymmetric second-r tensor operator which commutes with the Hamiltonian. The opera has the interpretation that in the rest system of the particle the space-space part is the spin and the space-time part is zero. In the quantized theory the second-rank tensor description of the polarization is a more appropriate notion than the four-vector description. The converse holds for the Foldy—Wouthuysen mean spin.

19098 UNIQUENESS OF THE ELECTRON POLARIZATION OPERATOR. M.E.Rose and R.H.Good, Jr.

Nuovo Cimento (Italy), Vol. 22, No. 3, 565-8 (Nov. 1, 1961).

The most general three-vector polarization operator, that commutes with the Hamiltonian and has the algebra of spin one-f, is constructed for a free Dirac particle. The non-uniqueness erent in this operator may be resolved by imposing either of the lowing two conditions: (1) the operator should be well-defined in rest system; (2) it should correspond to the space part of a r-vector operator evaluated in the rest system. In either case operator obtained is the Foldy--Wouthuysen transform of $\beta\sigma$.

19099 GAUGE THEORIES OF VECTOR PARTICLES.

S.L.Glashow and M.Gell-Mann.

. Phys. (USA), Vol. 15, No. 3, 437-60 (Sept., 1961).

The possibility of generalizing the Yang—Mills trick (Abstr. 93 of 1954) is examined. Theories are sought of vector bosons ariant under continuous groups of coordinate-dependent linear nsformations. All such theories may be expressed as super-sitions of certain "simple" theories; it is shown that each "simple" ory is associated with a simple Lie algebra. Mass terms for the tor bosons may be introduced at the price of destroying the ge-invariance for coordinate-dependent gauge functions. The ories corresponding to three particular simple Lie algebras — se which admit precisely two commuting quantum numbers — are mined in some detail as examples. One of them might play a role the physics of the strong interactions if there is an underlying er-symmetry, transcending charge independence, that is badly oken. The intermediate vector boson theory of weak interactions also discussed. The so-called "schizon" model cannot be made to nform to the requirements of partial gauge-invariance. It is poss-e, however, to find a formal theory of four intermediate bosons t is partially gauge-invariant and gives an approximate $|\Delta I| = \frac{1}{2}$ le.

19100 THE PRECESSION OF THE SPIN OF PARTICLES IN AN ARBITRARY FIELD. H.Bacry.

R. Acad. Sci. (France), Vol. 253, No. 3, 389-91 (July 17, 1961). French.

The result of Bargmann, Mickel, and Telegdi (Abstr. 11807 of 59) is generalized to the case of arbitrary fields. P.K.Kabir

19101 REGULAR NORMALIZATION OF SPIN-$\frac{1}{2}$ PLANE WAVES UNDER INVERSION OPERATIONS.

H.Tzou.

Phys. Radium (France), Vol. 21, No. 7, 579-86 (July, 1960). French.

It is shown that regular normalization is possible under eight itary inversions, but not for anti-unitary inversions, except C and M. Regular normalization is even possible for several multaneous inversions, in particular for TCP, M, CT and PM.

19102 A SPACE—TIME MODEL OF ISOSPACE.

G.R.Allcock.

clear Phys. (Internat.), Vol. 27, No. 2, 204-32 (Oct., 1961).

The principle of combined inversion indicates a close relation-ip between isospace and ordinary space. The possible nature of is relationship is demonstrated with the help of a model, in which e isospin, baryon number, hypercharge and charge conjugation erators of fundamental particles appear as displacement operators, oducing rotations within space—time itself. In the model the symmetry of isospace appears as a consequence of relativistic variance, and charge conugation and parity appear as continuous ansformations.

19103 VIRIAL THEOREM FOR MANY-ELECTRON DIRAC SYSTEMS. J.N.Bahcall.

ys. Rev. (USA), Vol. 124, No. 3, 923-4 (Nov. 1, 1961).

The virial theorem is derived for a system of N relativistic ectrons interacting with each other via electrostatic forces and bject to arbitrary external electromagnetic fields. The results are esented in a form that is useful in perturbation calculations and vestigations of nonisotropic systems. The equation of state for a stem of N electrons confined to a box is discussed on the basis of e virial theorem.

19104 REMARKS ON THE LOW-LYING BARYON ISOBARS.

R.E.Marshak and S.Okubo.

rogr. theor. Phys. (Japan), Vol. 26, No. 3, 381-90 (Sept., 1961).

The relative energies and widths of the low-lying baryon sobars are examined from the point of view of the global symmetry ypothesis. In particular, the energy shifts of the hyperon isobars * and Σ* due to the mass differences between the baryons are alculated independent of the dynamics.

19105 A BOSON DOUBLET EQUATION.

Kh.Yiglane and G.Kutuzova.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 780-1 (March, 1961). In Russian.

An equation for a boson doublet is set up. The equation is shown to be invariant to two transformations of the Pauli—Gürsey type. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 546-7 (Sept., 1961)].

19106 ELECTRODYNAMICS OF A ZERO MASS SPINOR PARTICLE. V.G.Vaks.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 792-800 (March, 1961). In Russian.

The electrodynamics of a massless two-component particle with charge e_1 is considered. Despite a number of peculiarities the theory turns out to be not internally inconsistent and is as complete as ordinary electrodynamics. A rough experimental estimate gives $e_1 \lesssim 10^{-8}$ e. The possibility that the known neutrinos carry such a charge e_1 is discussed. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 556-62 (Sept., 1961)].

19107 THE PARTICLE MASS IN THE ONE-DIMENSIONAL MODEL WITH FOUR-FERMION COUPLING.

V.G.Vaks and A.I.Larkin.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1392-8 (May, 1961). In Russian.

Superconductivity theory methods are employed for determining the particle mass in renormalized theories without a bare mass and involving a weak coupling constant. Only a zero solution for the mass exists in electrodynamics and the one-dimensional Thirring model. A non-zero solution was found in the one-dimensional model of two interacting fields. A finite expression for the charge was obtained for this model. [English translation in: Soviet Physics—JETP (USA)].

19108 QUASICLASSICAL PARTICLES IN A ONE-DIMENSIONAL PERIODIC POTENTIAL FIELD. A.M.Dÿkhne.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1423-6 (May, 1961). In Russian.

The widths of the energy gaps in the spectrum of a quasi-classical particle located in a one-dimensional periodic potential are calculated. The widths are found to be exponentially small. The pre-exponential factor and the energy spectrum near the band edges are determined. [English translation in: Soviet Physics—JETP (USA)].

19109 TWISTED SPACE AND NONLINEAR FIELD EQUATIONS. V.I.Rodichev.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1469-72 (May, 1961). In Russian.

It is shown that in twisted space the nonlinear spinor equations (used in the field theory of elementary particles) can be derived from a variational principle in which the Dirac Lagrangian is supplemented by a scalar space curvature. [English translation in: Soviet Physics—JETP (USA)].

THE FIVE-DIMENSIONAL REPRESENTATION OF PARTICLES OF SPIN 2, 1 AND 0. See Abstr. 18255

19110 A RELATIVISTIC PERTURBATION THEORY FOR A COULOMB FIELD. V.G.Gorshkov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1481-90 (May, 1961). In Russian.

Summation of the relativistic perturbation theory series is performed for a Coulomb field (used in particle theory). The relativistic perturbation theory series is represented in the form of a new series, each term of which can be represented linearly by an infinite non-relativistic series. An integral equation defining the terms of this series is obtained. All infrared divergences are collected together in a phase-shift factor. [English translation in: Soviet Physics—JETP (USA)].

19111 THE MAXIMUM VALUE OF THE COUPLING CONSTANT IN FIELD THEORY.

A.A.Ansel'm, V.N.Gribov, G.S.Danilov, I.T.Dyatlov and V.M.Shekhter.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 619-28 (Aug., 1961). In Russian.

It is assumed that the interaction between elementary particles is characterized by an effective range which depends only on the mass of the particles transferring the interaction. It is demonstrated that if all masses and together with them the interaction range are fixed, unitarity and analyticity lead to the restriction of the possible value of the π—N coupling constant and also of the absolute value of the π—π scattering amplitude at zero energy (if it is negative). The proof is carried out by employing the dispersion relations for the inverse function of the forward scattering amplitude. [English translation in: Soviet Physics—JETP (USA)].

19112 ON THE GAUGE INVARIANT THEORY OF ELEMENTARY PARTICLE INTERACTIONS.

P.Roman.
Nuovo Cimento (Italy), Vol. 21, No. 5, 747-63 (Sept. 1, 1961).

The weak interactions of elementary particles are derived from the principle of gauge invariance, following the general framework of Sakurai's investigations (Abstr. 3126 of 1961). It is found that only one new boson, an isospinor of the second kind, has to be introduced. The actual weak processes can be obtained by combining the basic V—A interaction, which automatically explains the $|\Delta t| = \frac{1}{2}$ and $|\Delta S| = 1$ rules, with various strong interactions. A systematic study of the electromagnetic interaction is presented, indicating that, besides the photon field, the hypercharge (and the isospin) boson field also play a role, giving rise to short-range corrections for the familiar electromagnetic interaction. It is pointed out that the weak and electromagnetic interactions destroy the strict gauge invariance of the second kind for bosons which transmit the strong interactions, and therefore make it possible for them to have a non-vanishing rest mass. Finally, the consequences of hypercharge and isospin assignments for leptons are investigated, and it is shown that such an assignment automatically leads to a "muon number" conserved in all interactions.

19113 ANALYTIC PROPERTIES OF THE THREE POINT FUNCTION.

G.Bonnevay, I.J.R.Aitchison and J.S.Dowker.
Nuovo Cimento (Italy), Vol. 21, No. 6, 1001-11 (Sept. 16, 1961).

For the vertex function in lowest order, the part of the Landau surface which is singular on the physical sheet is identified for the general case of three complex external masses. The result is extended for the seven other sheets obtained by crossing the normal (two-particle) branch cuts. Applications to production processes and reactions involving resonant or unstable states are indicated.

19114 SOLUBLE MODEL OF A BREAK-UP PROCESS.

H.M.Nussenzveig.
Proc. Roy. Soc. A (GB), Vol. 264, No. 1318, 408-30 (1961).

The exact solution of a one-dimensional problem, representing the scattering of a particle by another particle which is bound to a fixed centre of force, is given. All the interactions have zero range and are described by boundary conditions. The possible processes are elastic scattering and break-up of the bound system. The elastic scattering and break-up amplitudes are explicitly determined, and the behaviour of the corresponding cross-sections is discussed. At high energies, the incident particle tends to transfer its whole momentum to the bound one, giving rise to a strong peak in the break-up cross-section. The analytic behaviour of the amplitudes is examined. The Riemann surface of the elastic scattering amplitude has three sheets. The break-up threshold gives rise to cubic-root branch points. The remaining singularities are a finite number of poles. The exact amplitudes are compared with those given by the impulse approximation (in first and second order) and by Born's approximation. It is found that these approximations are reliable only at high incident energies and within the width of the dominant peak of the break-up cross-section.

19115 SYMMETRY OF THE STRONG INTERACTION IN THE FOUR-DIMENSIONAL ISOTOPIC-SPIN SPACE AND IN THE THREE-DIMENSIONAL κ-SPACE.

S.Nakamura and S.Sato.
Progr. theor. Phys. (Japan), Vol. 26, No. 2, 231-50 (Aug., 1961).

Without using strangeness a variant theory of higher symmetry is proposed for the strong interactions of baryons. Baryons are classified into two groups: (p,n,Ξ^0,Ξ^-) called the p-group and $(\Sigma^+,\Sigma^0,\Sigma^-,\Lambda)$ called the q-group in terms of a new quantum number $\kappa_3 = \frac{1}{2}$ for the p-group and $\kappa_3 = -\frac{1}{2}$ for the q-group. p and q make a spinor in the three-dimensional κ-space. Each group is, in turn, considered to represent a vector in the four-dimensional isotopic spin space, called N-space, which can be reduced to define two sets of spin matrices τ and ζ, the sum of the third components of which are related to the electric charge of baryons: $Q_e = \tau_3 + \zeta_3$. In order to give an interaction Hamiltonian symmetric in κ-space and also in N-space, which are orthogonal to each other, sixteen kinds of mesons with spin 0 are introduced which mediate the st interaction of the Yukawa type among baryons. Under the requi ment of rotational invariance for the interaction Hamiltonian in t N-κ space, the character of mesons is naturally defined. It is shown that pions correspond to the component of $\kappa_3 = 0$, $\kappa = 0$; strangeness-two mesons to $\kappa_3 = 0$, $\kappa = 1$; and kaons to $\kappa_3 = \pm 1$, $\kappa =$ Two kinds of kaons are introduced, one called K-kaons exclusive coupling nucleons with the Σ- and Λ-particles, and the other cal L-kaons coupling the Ξ-particle with the Σ- and Λ-particles. It shown that this scheme covers the current thory of higher symm and the strangeness rule with the additional selection rule $\Delta\kappa_3 =$ which enables one to forbid the processes: $\Xi^- + p \rightarrow \Lambda + \Lambda$, $D^- + p$ $+ p \rightarrow \Sigma^+ + \Lambda$, etc. A number of experiments in hyperon-meson physics are, therefore, proposed which permit a selection betwe the present scheme and current theory.

19116 ASYMPTOTIC BEHAVIOUR OF CROSS-SECTIONS A HIGH ENERGIES.

V.B.Berestetskii and I.Ya. Pomeranchuk.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1078-86 (Oct., 1960). In Russian.

The transformation of two particles into three or four partic at high energies is treated in the pole approximation. In the ene region in which the total elastic scattering cross-section is inde dent of the energy, the cross-section for the transformation of tv particles into three does not decrease with increasing energy. T cross-section for the transformation of two particles into four ir creases logarithmically with the energy. This result seems to i cate that at very high energies the elastic scattering cross-secti tends to zero. [English translation in: Soviet Physics—JETP (U Vol. 12, No. 4, 752-7 (April, 1961)].

19117 ENERGY FLUCTUATIONS IN PARTICLE INTERACTIONS AT HIGH ENERGIES.

N.M.Gerasimova.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1087-90 (Oct., 1960). In Russian.

Considers fluctuations in the energy given to particles of a particular kind in an elementary interaction at high energy. The calculations are carried out on the basis of the hydrodynamical theory of multiple particle production. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 758-60 (April, 1961

19118 A METHOD FOR THE CALCULATION OF THE STAT TICAL WEIGHTS AND DISTRIBUTIONS IN THEORIE OF MULTIPLE PRODUCTION.

G.I.Kopȳlov.
Zh. eksper. teor. Phys. (USSR), Vol. 39, No. 4(10), 1091-8 (Oct., 1960). In Russian.

An effective method is developed for obtaining the distributi and correlations in arbitrary models of multiple production. The formulae for the covariant model are especially simple. It is sh how a study of this model may facilitate the calculations for mor complicated models. [English translation in: Soviet Physics—JE (USA), Vol. 12, No. 4, 761-5 (April, 1961)].

19119 A MODEL FOR NON-LEPTONIC WEAK INTERACTI

W.B.Zeleny.
Nuovo Cimento (Italy), Vol. 21, No. 6, 958-65 (Sept. 16, 1961).

The suggestion is made that the non-leptonic weak interacti may be completely dissimilar to the leptonic weak interaction. this assumption, a simple model for the non-leptonic weak interaction is given. The model is based on Pais' idea of a "parity clash" and is constructed to give the $|\Delta T| = \frac{1}{2}$ rule and the obser asymmetry parameters in pionic hyperon decays.

19120 THE EFFECT OF WEAK INTERACTION ON THE ELECTROMAGNETIC PROPERTIES OF PARTICLES

Ya.B.Zel'dovich and A.M.Perelomov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1115-25 (Oct., 1960). In Russian.

The contribution to the electromagnetic interaction caused by the weak interaction of particles is examined. In some cases the order of this contribution in the weak-interaction constant is diff ent in the theory of the direct four-fermion interaction and in the theory with an intermediate vector boson. Estimates are given f the magnetic-moment correction and for the parity nonconservati of the "anapole" interaction of particles with the electromagnetic field. Expressions are given for the scattering of neutrinos in th Coulomb field of a nucleus, and the polarization of recoil protons from the scattering of electrons is examined. The possibility of istence of weak neutral currents is considered, and the influence of ch currents on the scattering of electrons by protons and on atomic ects is discussed. [English translation in: Soviet Physics—JETP SA), Vol. 12, No. 4, 777-84 (April, 1961)].

19121 A SCHEME OF WEAK INTERACTIONS WITH NEUTRAL CURRENTS. V.N.Baier and I.B.Khriplovich.

ı. eksper. teor. Fiz. (USSR), Vol. 39, No. 5, 1374-80 (Nov., 1960). Russian.

The cross-sections for scattering and annihilation in the collision light particles due to weak interaction are calculated. The degree longitudinal polarization in such nucleon—nucleon scattering is estiated. Effects caused by weak interaction between the electrons in the edium are considered. [English translation in: Soviet Physics—TP (USA), Vol. 12, No. 5, 959-63 (May, 1961)].

19122 ELECTROMAGNETIC CORRECTIONS TO WEAK INTERACTIONS. I.F.Ginzburg and V.V.Serebryakov.

ı. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1738-45 (June, 1961).

The procedure of calculating corrections is studied. It is own that at present there is no basis for asserting that the upling constants of various weak interaction processes are equal unequal with an accuracy better than the electromagnetic. nglish translation in: Soviet Physics—JETP (USA)].

19123 RECURRENT CONSTRUCTION OF ANGULAR OPERATORS. II. INTRODUCTION OF AN INTEGRAL IN AND AN ARBITRARY ORBITAL MOMENTUM.

ı.Fisher [J.Fischer] and S.Chulli [S.Ciulli].

ı. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1349-56 (Nov., 60). In Russian.

The method previously proposed (Abstr. 4771 of 1961) for actical construction of angular operators, in which one uses only fferential operations, is applied to study the change in the form of e angular operators resulting from the adding of a new orbital gular momentum or an integer spin to the process. Formulae r practical computations and examples are given. [English anslation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 941-5 ay, 1961)].

19124 SEMI-ANALYTICAL SOLUTION OF EQUATIONS OF THE CHEW—MANDELSTAM TYPE.

u.A.Simonov and K.A.Ter-Martirosyan.

h. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1442-9 (Nov., 1960). Russian.

A simple method is proposed which rapidly yields an approxiate solution. The method is applied to the Chew—Mandelstam quation for the interaction of neutral and charged pions. The esults of the first approximation in the case of charged pions are ompared with the numerical calculation of Chew, Mandelstam, d Noyes (in press). [English translation in: Soviet Physics—ETP (USA), Vol. 12, No. 5, 1003-7 (May, 1961)].

19125 MARSHAK INVARIANCE AND FOUR-FERMION INTERACTIONS. Kh.Ȳiglane.

h. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 782-3 (March, 1961). Russian.

A classification of baryons and leptons which is useful for escribing weak interactions is proposed. Marshak invariance is eneralized to all baryons and leptons. [English translation in: oviet Physics—JETP (USA), Vol. 13, No. 3, 548-9 (Sept., 1961)].

19126 RELATIVISTIC GENERAL THEORY OF REACTIONS OF THE $a + b \rightarrow c + d + e + \ldots$ TYPE. M.I.Shirokov.

h, eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1387-91 (May, 1961). Russian.

A relativistic theory of reactions with three or more product articles is developed. It is a generalization of the relativistic eory of reactions of the $a + b \rightarrow c + d$ type in the Jacob and Wick bstr. 12531 of 1959) and Chzhou Guan-chzhao [Chou Kuang-chao] bstr. 13007 of 1959) form. It was found that other variables hould be used as the relative momenta, instead of the Jacob ariables. Selection rules, which can be deduced from parity onservation, are presented. [English translation in: Soviet hysics—JETP (USA)].

19127 SYMMETRY PROPERTIES OF STRONG INTERACTIONS. V.M.Shekhter.

h. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 810-20 (Sept., 961). In Russian.

A method is proposed which can be employed to find all (those that are in principle possible) symmetry properties of strong interactions providing the most general (in the sense of the bare coupling constant values and particle masses) form of the Lagrangian is given. The method is applied to a Lagrangian in the Yukawa form and to the composite model with four-fermion coupling. [English translation in: Soviet Physics—JETP (USA)].

19128 REARRANGEMENT COLLISIONS IN THE BORN APPROXIMATION. M.Demeur and C.Joachain.

Bull. Acad. Roy. Belgique Cl. Sci., Vol. 47, No. 5, 368-80 (1961). In French.

The asymptotic behaviour of the total wave-function furnishes a criterion for the validity of the Born approximation; the masses of the particles involved in the process are the only parameters appearing in the criterion. Some cases of atomic or nuclear collisions are investigated; the information given by the criterion is in good agreement with the conclusions deduced from a comparison between explicit calculations and experimental results.

19129 THEORY OF RELATIVISTIC COULOMB SCATTERING. I. V.G.Gorshkov.

Zh. eksper. teor. Fiz. (USSR), Vol. 41. No. 3(9), 977-84 (Sept., 1961). In Russian.

The cross-section for scattering of charged spinor particles in the Coulomb field of a nucleus is calculated by taking into account the finite size of the nucleus and screening. The relative accuracy of the calculation is of the order of $(\alpha Z)^2$. The calculations are all based on the Furry—Sommerfeld—Maue function and lead to an analytic formula for the cross-section. [English translation in: Soviet Physics—JETP (USA)].

19130 THE CONSTRUCTION OF THE SCATTERING MATRIX IN NONLOCAL THEORY. V.D.Kukin and A.R.Frenkin.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 5, 1089-92 (Aug. 11, 1961). In Russian.

The introduction of form factors into an S-matrix involves difficulties with causality and the definition of a T-product. These have to some extent been overcome but at the expense of the unitarity of the S-matrix. The author shows how, by the addition of iR, where R is a Hermitian operator, to the Lagrangian density in the definition of the S-matrix, unitarity is preserved and also causality in a relaxed form is satisfied. It is shown how, in principle, R can be determined. [English translation in: Soviet Physics—Doklady (USA)]. C.Wilkin

19131 LOCAL FIELDS WITH TERMINATING EXPANSIONS. K.Bardakci and E.C.G.Sudarshan.

Nuovo Cimento (Italy), Vol. 21, No. 5, 722-9 (Sept. 1, 1961).

The class of field theories in which the current admits of a terminating expansion in a free field is studied. It is shown that, if one imposes the condition of locality, the current in question reduces to a local polynomial and the resulting field has the trivial S-matrix unity.

19132 CONTRIBUTION TO THE STUDY OF NONRELATIVISTIC DISPERSION FORMULAE. R.Ceuleneer.

Bull. Acad. Roy. Belgique Cl. Sci., Vol. 47, No. 5, 406-26 (1961). In French.

The influence of a cut-off on a central potential is studied by means of the poles of the scattering matrix S(k). Poles which are practically independent of this cut-off are called stable; it is proved that these poles are contained in the analyticity strip of S(k). A dispersion relation is constructed for which the resonant terms and the potential scattering term are stable.

19133 DISPERSION RELATIONS IN THE NONRELATIVISTIC SCATTERING THEORY WITH SPIN—ORBIT INTERACTION. V.S.Buslaev.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1422-6 (Nov., 1960). In Russian.

Dispersion relations for the scattering of spin-$\frac{1}{2}$ particles by a potential containing the spin—orbit interaction are derived in nonrelativistic theory. The behaviour of the Green's function of the total Hamiltonian at large complex energies is investigated. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 990-2 (May, 1961)].

19134 DISPERSION RELATIONS AND DIFFRACTION SCATTERING. P.T.Matthews and A.Salam.

Nuovo Cimento (Italy), Vol. 21, No. 5, 823-8 (Sept. 1, 1961).

An approximate formula for high-energy elastic scattering is derived from dispersion relations.

19135 SOME PROPERTIES OF HIGH ANGULAR MOMENTUM PARTIAL WAVE SCATTERING AMPLITUDES.

P.B.Jones.

Nuovo Cimento (Italy), Vol. 21, No. 6, 1012-19 (Sept. 16, 1961).

The form of the amplitude at low energy is shown to determine $l-1$ moments of the function, in the partial-wave dispersion relation, which is the discontinuity across the unphysical branch cut. An inequality is given for the number of zeros in this function. The form of the moment sequence necessary to give a partial-wave scattering amplitude consistent with unitarity and the partial-wave dispersion relations is investigated. It is suggested that the sequence must be such that the absorption is a slowly varying function of the impact parameter.

19136 ANALYTIC PROPERTIES OF OFF-ENERGY SHELL POTENTIAL SCATTERING AMPLITUDES. D.I.Fivel.

Nuovo Cimento (Italy), Vol. 22, No. 2, 326-51 (Oct. 16, 1961).

A proof is given that a double dispersion relation in the momentum transfer and outgoing energy holds for off-energy shell scattering by a Yukawa potential in which the incoming energy is held fixed and real. It is shown that unitarity then determines the off-shell in terms of the on-shell amplitude. The analytic properties of the off-shell amplitude on unphysical Riemann sheets are described and some results on the domain of holomorphy in both energy variables are also included.

19137 SIMPLIFICATION OF THE TWO-BODY UNITARITY RELATION. M.Froissart.

Nuovo Cimento (Italy), Vol. 22, No. 2, 395-401 (Oct. 16, 1961).

A reduction is obtained in the number of integrations needed to compute the scattering amplitude from a potential by dispersion—theoretical methods.

19138 TALMI TRANSFORMATIONS FOR PARTICLES WITH DIFFERENT MASSES. Yu.F.Smirnov.

Nuclear Phys. (Internat.), Vol. 27, No. 2, 177-87 (Oct., 1961).

A general formula for Talmi coefficients is obtained, making it possible to pass from the wave-functions of two particles having different masses μ_1 and μ_2 moving in the oscillator potential

$$V(r_1,r_2) = \tfrac{1}{2}\mu_1\omega r_1^2 + \tfrac{1}{2}\mu_2\omega r_2^2$$

to the wave-functions describing the relative motion of these particles and the motion of their centre of mass. These coefficients are necessary for isolating the motion of the centre-of-mass of several nucleons in the shell model. They are also applied in calculating the energy matrix, etc.

19139 MANDELSTAM REPRESENTATION FOR DIRAC POTENTIAL SCATTERING. K.W.Edwards.

Phys. Rev. (USA), Vol. 124, No. 3, 936-9 (Nov. 1, 1961).

The scattering amplitude for Dirac potential scattering is shown to have a Mandelstam representation if the potential is a superposition of Yukawa potentials. This representation together with the unitarity condition is used to obtain an integral equation for the weight functions. The subtraction in energy makes it necessary to know the scattering amplitude's dependence on momentum transfer at zero energy in order to solve for the weight functions. Dispersion relations for the partial wave amplitudes are obtained.

19140 INTEGRAL REPRESENTATIONS FOR SCATTERING AMPLITUDES IN PERTURBATION THEORY.

N.Nakanishi.

Progr. theor. Phys. (Japan), Vol. 26, No. 3, 337-55 (Sept., 1961).

Integral representations are proposed, which are more general than the Mandelstam representation (Abstr. 4941 of 1959). Their support properties are investigated for some practical cases and for the general case in every order of perturbation theory. In the appendices, Nambu—Symanzik's formula (Abstr. 872 of 1958; 15292 of 1960) is proved in terms of the Feynman parametric integral, and an example (for two-particle scattering) is given in which stability conditions are satisfied but no dispersion relation holds.

19141 SELF-CONSISTENT CALCULATION OF THE MASS AND WIDTH OF THE J = 1, T = 1, ππ RESONANCE.

F.Zachariasen.

Phys. Rev. Letters (USA), Vol. 7, No. 6, 268 (Sept. 15, 1961).

An error was made in the numerical computation reported earlier (Abstr. 12100 of 1961): the mass value $m_\rho \sim 950$ MeV should be $m_\rho \sim 350$ MeV. J.E.Pa

19142 THE INFLUENCE OF INELASTIC PROCESSES ON ELASTIC SCATTERING IN THE VICINITY OF THRESHOLDS FOR INELASTIC REACTION MODES. L.A.Khalfin.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1020-2 (Oct., 19
In Russian.

It is shown that the specific effects that occur in the vicinity thresholds for inelastic reactions can be treated in the general ca by using dispersion relations. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 709-10 (April, 1961)].

19143 DISTORTED WAVE EXPANSION FOR SCATTERING PROBLEMS. P.Swan.

Nuclear Phys. (Internat.), Vol. 27, No. 4, 620-31 (Nov., 1961).

The properties of a distorted wave method for the scattering wave-function $\psi_l(r)$ and phase shift δ_l are examined. For $|\delta_l| <$ $\tan^{(1)} \delta_l$ reduces to a series whose leading term is the first Born approximation for $\tan \delta_l$, whereas at low energies an approximate form of the shape-independent formula is obtained. For weak pote tials ($|\delta_l(k)| \leq \pi$ for all k), the method is valid for all k, but for strong potentials the assured range of validity is $|\delta_l| < \frac{1}{2}\pi$, provid the energy is sufficiently high. The overall accuracy if 2-3% for using non-singular potentials. Potentials singular at $r = 0$ may gi rather lower accuracy. Higher approximations in the form of seri expansions for $\psi_l^{(n)}(r)$ and $\tan \delta_l^{(n)}$ are developed, which reduce i the limit $n \to \infty$ to the corresponding Born series, convergent for $|\delta_l| < \frac{1}{2}\pi$. However, the rate of convergence for small n is much better than for the Born expansions, particularly for potential strengths near the radius of convergence. The expansions are als convergent for weak potentials when $\pi \geq |\delta_l| > \frac{1}{2}\pi$, whereas the B series are not. It is concluded that $\psi_l^{(1)}(r)$ and $\tan^{(1)} \delta_l$ are approx mate summations of the corresponding Born series for $|\delta_l| < \frac{1}{2}\pi$, and therefore include contributions from the Born expansions of al orders. The summations for $\psi_l^{(n)}(r)$ and $\tan \delta_l^{(n)}$ are also valid f weak potentials for $\pi \geq |\delta_l| \geq \frac{1}{2}\pi$, having the character of Born ex pansions in inverse powers. The method is illustrated on zero-energy neutron—proton scattering.

19144 SCATTERING THEORY FOR A THREE-PARTICLE SYSTEM. L.D.Faddeev.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1459-67 (Nov., 1960). In Russian.

It is shown that the eigenfunctions of the Hamiltonian of a thre particle system with pair interaction can be represented in a natural fashion as the sum of three terms, for each of which there exists a linked set of equations. This set can be written down with the help of the solutions of the pair problems, and can be solved uniquely, in contrast to the equations of the Lippman—Schwinger type (Abstr. 8498 of 1950). In the limit of zero range, the well-known Skornyakov—Ter-Martirosyan equations (Abstr. 3004 of 195 are obtained. [English translation in: Soviet Physics—JETP (USA Vol. 12, No. 5, 1014-19 (May, 1961)].

19145 THE STRUCTURE OF THE RESOLVENT OPERATOR FOR A SCHRÖDINGER SYSTEM OF THREE PARTICL WITH A TWO-BODY INTERACTION. L.D.Faddeev.

Dokl. Akad. Nauk SSSR, Vol. 138, No. 3, 565-7 (May 21, 1961).
In Russian.

Some results based on an integral equation obtained previousl (see preceding abstract) are derived for the behaviour of the resolvent operator of a three-body system on the complex plane. A fundamental result which provides an upper bound for the operator is formulated as a theorem. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 5, 384-6 (Oct., 1961)]. D.J.Thoule

19146 A FUNCTIONAL EXPANSION OF THE SCATTERING MATRIX IN NORMAL PRODUCTS OF ASYMPTOTIC FIELDS. B.V.Medvedev.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 826-38 (March, 196
In Russian.

Formulae which formally express the coefficient functions of the scattering matrix expansion in normal products of asymptotic lds in terms of time-ordered products of the current operators 1 a certain set of operators Λ_ν are derived by an axiomatic thod without recourse to perturbation theory. Systems of equa ns for the coefficient functions of the scattering matrix are also ablished. [English translation in: Soviet Physics—JETP (USA), l. 13, No. 3, 580-8 (Sept., 1961)].

19147 RELATIVISTICALLY COVARIANT RELATIONS BETWEEN POLARIZATION EFFECTS IN THE ATTERING OF SPIN $\frac{1}{2}$ PARTICLES. G.V.Frolov.

. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 943-5 (March, 1961). Russian.

The relations between all quantities characterizing polarization ects in the scattering of different and identical particles of spin $\frac{1}{2}$ e derived in a relativistically covariant form. [English translation Soviet Physics—JETP (USA), Vol. 13, No. 3, 659-60 (Sept., 1961)].

19148 NATURE OF THE AMPLITUDE SINGULARITIES IN QUANTUM FIELD THEORY. A.P.Rudik.

. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1473-5 (May, 1961). Russian.

Restrictions on the singularities of amplitudes in the quantum ld theory of particles are derived by perturbation theory methods. nglish translation in: Soviet Physics—JETP (USA)].

19149 A POSSIBLE ASYMPTOTIC BEHAVIOUR OF ELASTIC SCATTERING. V.N.Gribov.

ı. eksper. teor. Fiz. (USSR), Vol. 41, No. 2, 667-9 (Aug., 1961). Russian.

A possible asymptotic behaviour of the scattering amplitude, ffering from the classical picture, is discussed with reference the Mandelstam representation, the potential analogy and turation of the unitarity relation. [English translation in: Soviet ıysics—JETP (USA)].

T.Burke

19150 CALCULATION OF THE PION—NUCLEON AMPLITUDE BY TAKING INTO ACCOUNT THE -π INTERACTION. A.D.Galanin and A.F.Grashin.

ı. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 633-43 (Aug., 1961). Russian.

Dispersion relations for invariant π—N amplitudes similar to ose employed by Bowcock et al. (Abstr. 15408 of 1960, 5764 of 61), are considered. The relations contain additional subtractions th respect to energy s (one subtraction) and transferred momen m t (two subtractions). They are regarded as integral equations th kernels depending on the S, P and D amplitudes for π—π scat ring. All quadratures obtained in the solution of the equations are aluated for the simple π—π phase shift model which is a general ation of the effective interaction range approximation. Simple ıalytic expressions are obtained for the contribution of π—π teraction to the π—N amplitude. It is shown that in the calculations eviously performed the convergence of the integrals along the ıt $t \geq 4\mu^2$ (μ is the π-meson mass) was not sufficiently rapid and nce the conclusions drawn on the basis of these calculations are t very reliable. [English translation in: Soviet Physics—JETP SA)].

19151 THE SCATTERING EQUATIONS FOR LOW ENERGIES. V.V.Malakhov.

h. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 762-4 (Sept., 1961). Russian.

Equations are proposed for the partial scattering amplitudes r low energies. In deriving these equations use is made of the uble Mandelstam representation and unitarity condition in the o particle approximation. A characteristic feature of the quations is that the number of subtractions allowed by them does t depend on the number of waves taken into account. [English anslation in: Soviet Physics—JETP (USA)].

CHANGE IN THE MOMENTA OF CHARGES COLLIDING IN A AGNETIC FIELD. See Abstr. 18989

19152 ANALYTICAL PROPERTIES OF A SQUARE DIAGRAM WITH NON-DECAYING MASSES.

.N.Gribov, G.S.Danilov and I.T.Dyatlov.
h. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 924-36 ept., 1961). In Russian.

A concrete form of the dispersion representations in energy and transferred momentum is derived for the simplest square diagram with non-decaying masses. [English translation in: Soviet Physics—JETP (USA)].

FORM FACTORS AND VECTOR MESONS. See Abstr. 19243

19153 METHOD OF SUCCESSIVE EXTENSION OF THE SPECTRAL FUNCTIONS IN THE MANDELSTAM REPRESENTATION. F.M.Kuni and I.A.Terent'ev.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 866-78 (March, 1961). In Russian.

A method is developed which makes it possible to extend the range of knowledge of the spectral functions and absorption parts, by a series of successive steps, from a knowledge of the absorption part of the scattering amplitudes specified in the physical region. By means of this method, the NN scattering amplitude can be expressed in terms of the $\pi\pi$ and πN scattering amplitudes, specified only in the physical regions. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 607-15 (Sept., 1961)].

19154 THE DEGENERATE SUPERDENSE GAS OF ELEMENTARY PARTICLES. V.A.Ambartsumyan and G.S.Saakyan.

Astron. Zh. (USSR), Vol. 37, No. 2, 193-209 (March-April, 1960). In Russian.

The composition of a degenerate gas whose density is of the order of nuclear density or higher, is considered. The temperature is assumed so low that all types of fermions are degenerate. It is shown that, with increasing density, different hyperons should successively appear and increase in number. They should be stable because of the Pauli principle. The threshold densities of different hyperons are calculated. Paradoxically, the smallest threshold density does not correspond to the Λ-hyperon, having the smallest mass of rest, but to the Σ^- - hyperon. In accordance with this, a sufficiently massive cosmic body in gravitational equilibrium should consist of a hyperon core, a neutron layer, and an outer envelope having the usual composition (electrons, protons, and composite nuclei). [English translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 2, 187-201 (Sept.-Oct., 1960)].

19155 GAUGE TRANSFORMATIONS OF GREEN'S FUNCTIONS. V.I.Ogievetskii and I.V.Polubarinov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 926-32 (March, 1961). In Russian.

A law is obtained for the transformation of many-particle Green's functions under changes of gauge. General identities of the type of Ward's identity follow from this law. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 647-51 (Sept., 1961)].

19156 THE USE OF PROJECTION OPERATORS TO OBTAIN THE MATRIX ELEMENTS FOR PARTICLES OF SPIN $\frac{1}{2}$. E.Bellomo.

Nuovo Cimento (Italy), Vol. 21, No. 5, 730-9 (Sept. 1, 1961). In Italian.

For the purpose of writing down formulae for immediate computation in relativistic form of matrix elements between free states for a particle of spin $\frac{1}{2}$, use of projection operators is made. Explicit expressions are obtained which allow the computation of matrix elements of any operator up to a phase.

19157 THE COLLISION INTEGRAL FOR CHARGED PARTICLES. V.P.Silin.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1768-74 (June, 1961). In Russian.

The correlative distribution function equation which takes into account the screening of the charged particle interaction, previously derived by Klimontovich and Temko (Abstr. 3200 of 1958), is solved. The correlation function is found. The collision integral is obtained for a multi-type system of relativistic charged particles. The integral is valid, in particular, in describing states which strongly differ from the thermodynamic equilibrium state. It is shown that screening of a Coulomb interaction can be described by a complex dielectric permeability tensor. This circumstance permits one to extend the treatment to the case of relativistic distributions and to obtain a relativistic collision integral which takes into account the screening of the charged particle field. [English translation in: Soviet Physics—JETP (USA)].

ELEMENTARY PARTICLES

19158 ENERGY DEPENDENCE OF CROSS-SECTIONS NEAR THE "THRESHOLD" FOR UNSTABLE PARTICLE PRODUCTION. A.I.Baz'.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1511-15 (May, 1961). In Russian.

The energy dependence of the cross-sections for elastic scattering, X(a,a)X, and for the reaction X(a,b)Y are determined near the "threshold" for production of an unstable particle Y which decays immediately after its production ($Y \rightarrow c + d$). The results obtained may be useful in nuclear physics. [English translation in: Soviet Physics—JETP (USA)].

19159 PRODUCTION OF LEPTON PARTICLE PAIRS ON A COULOMB CENTRE.
M.A.Kozhushner and E.P.Shabalin.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 949-53 (Sept., 1961). In Russian.

The cross-sections for the processes

$$\nu + A \rightarrow \nu + A + \mu^+ + \mu^- \text{ and } \mu + A \rightarrow \mu + A + \nu + \bar{\nu}$$

occurring in the Coulomb field of the nucleus are calculated. It is shown that the Weizsäcker—Williams method (1934) can be applied to perform the calculation in the case under consideration. [English translation in: Soviet Physics—JETP (USA)].

19160 THE MINIMAL NUMBER OF PARTIAL WAVES IN REACTIONS INVOLVING THE FORMATION OF SEVERAL PARTICLES.
Syan' Din-chan [Hsien Ting-ch'ang] and Chen' Tsun-mo [Ch'en Ts'ung-mo].
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 784-9 (Sept., 1961). In Russian.

A universal inequality is derived which determines the minimal number of partial waves participating in a reaction involving the formation of more than two particles in the final state. [English translation in: Soviet Physics—JETP (USA)].

19161 ENERGY DEPENDENCE OF THE SCATTERING CROSS-SECTION AT SMALL ENERGIES. S.M.Bilen'skii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 714-15 (Feb., 1961). In Russian.

In the presence of inelastic scattering, the low-energy cross-section contains a term proportional to the momentum, the coefficient of which is a numerical multiple of the inelastic cross-section. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 499-500 (Aug., 1961)]. J.E.Paton

Photons

19162 TRANSITION RADIATION IN THE CASE OF A DIFFUSE BOUNDARY BETWEEN TWO MEDIA.
A.Ts.Amatuni and N.A.Korkhmazyan.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1011-19 (Oct., 1960). In Russian.

The transition radiation of a charged relativistic particle is considered in the case of a diffuse boundary between two media. General formulae are obtained for the main part of the radiation, and a detailed study is made of the case when the dimension of the diffusion zone z_0 is much smaller than that of the zone where the transition radiation is produced in either medium, R_0 or R_m, and also the cases when $z_0 \gg R_0 > R_m$ and $R_m \ll z_0 \ll R_0$. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 703-8 (April, 1961)].

19163 THE RADIATION FROM A CHARGE MOVING IN AN INHOMOGENEOUS MEDIUM. S.P.Kapitsa.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1367-70 (Nov., 1960). In Russian.

The problem considered is that of the radiation from a uniformly moving charge in a medium with random inhomogeneities. Expre sions are obtained for the intensity, the polarization, and the directivity of the radiation. It is pointed out that as the threshold for the Cherenkov effect is approached there is a logarithmic increase of the radiated intensity. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 954-6 (May,1961)].

19164 LEFT—RIGHT ASYMMETRY IN COMPTON SCATTERING BY TRANSVERSALLY POLARIZED ELECTRONS. S.C.Miller and R.M.Wilcox.
Phys. Rev. (USA), Vol. 124, No. 3, 637-9 (Nov. 1, 1961).

A left—right asymmetry in the Compton scattering cross-se is found for the case when only the target electron is polarized. The incident photon is unpolarized and the polarization of the outgoing photon and electron are assumed not to be measured. This assymetry results from a radiative correction. It is found that t maximum asymmetry is about one part in a thousand.

19165 ON RESONANCE PHOTON—PHOTON SCATTERING. V.N.Oraevskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1049-50 (Oct., 1960). In Russian.

The effective cross-section for resonance photon—photon scattering due to the existence of a π^0 meson decaying into two photons is estimated. [English translation in: Soviet Physics—J (USA), Vol. 12, No. 4, 730 (April, 1961)].

19166 A METHOD FOR THE MEASUREMENT OF GAMMA-RAY SPECTRA IN OMNIDIRECTIONAL GAMMA-RA FIELDS. L.C.Thompson.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 175-80 (Nov., 1960).

A method is presented for analysing pulse-height distributio from a scintillation detector exposed to an omnidirectional gamm ray field through a collimator opening in a lead shield. The met is a combination of analytical and experimental procedures and provides corrections for collimator penetration and scattering effects.

19167 MULTICHANNEL PAIR GAMMA SPECTROMETER. I. CALCULATION OF THE BASIC PARAMETERS O THE GAMMA SPECTROMETER. Yu.D.Baiukov, M.S.Kozodaev, A.A.Markov, A.N.Sinaev and A.A.Tiapkin.
Pribory i Tekh. Eksper. (USSR), 1958, No. 6, 23-9 (Nov.-Dec.). In Russian.

The results of calculations of the resolving power and efficiency of the spectrometer are given. The bases for choosin the optimum geometry of a multichannel system are given. [English translation in: Instrum. exper. Tech. (USA), No. 6, 737 (Nov.-Dec., 1958; publ. Oct., 1959)].

19168 MULTICHANNEL PAIR GAMMA SPECTROMETER. II. DESCRIPTION OF A 12-CHANNEL SPECTROME
Yu.D.Baiukov, M.S.Kozodaev, A.A.Markov, A.N.Sinaev and A.A.Tiapkin.
Pribory i Tekh. Eksper. (USSR), 1958, No. 6, 30-40 (Nov.-Dec.). In Russian.

A description is given of a 12-channel magnetic pair spectro meter used for the investigation of γ-radiation produced in the decay of neutral π-mesons produced in a synchrocyclotron. The instrument can be used for measuring the energy of γ-spectra between 20 and 600 MeV. [English translation in: Instrum. expe Tech. (USA), No. 6, 745-55 (Nov.-Dec., 1958; publ. Oct., 1959)].

19169 POLARIZATION OF γ-QUANTA IN THE BREMSSTRAHLUNG OF ELECTRONS ON PROTONS.
A.A.Kresnin.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 137-40 (1960). In Ukrain

Formulae, taking into account the recoil of the proton, are o tained in the form of an expansion in powers of q/M to the first o der only.

19170 ON THE QUANTUM THEORY OF THE VAVILOV—CHERENKOV RADIATION EMITTED BY A PARTICL WITH A MAGNETIC MOMENT. A.B.Kukanov.
Optika i Spektrosk. (USSR), Vol. 10, No. 3, 289-96 (March, 1961 In Russian.

The methods of relativistic quantum electrodynamics are used investigate the emission of Vavilov—Cherenkov radiation by a rticle having a magnetic moment and moving in a ferroelectric edium. Tow possible forms of the interaction (μ_0; $\vec{B}$, $\vec{E}$, and ; $\vec{H}$, $\vec{D}$) between the magnetic moment and the quantized electro-gnetic field in the medium are considered. The polarization of radiation is studied. The character of the radiation and the antum mechanism of the emission process are considered in tail in the extreme relativistic case ($\beta \rightarrow 1$), and also for $\cos\theta = 1$. nglish translation in: Optics and Spectrosc. (USA), Vol. 10, No. 3, 7-50 (March, 1961)].

-rays

19171 SPECTRA OF SCATTERED RADIATION BEHIND SLABS OF WATER IRRADIATED BY X-RAYS.

Bjärngard and G.Hettinger.
k. Fys. (Sweden), Vol. 20, Paper 36, 517-26 (1961).

The radiation scattered by water slabs was measured in absolute its with a NaI scintillation spectrometer. The primary radiation s obtained from an X-ray generator supplied with thick filters. using the memory of a multichannel analyser, the spectra in ferent directions were integrated over all angles to give the herical flux. The integrated radiation behind the slabs was mpared with that present at equal depth in a semi-infinite water antom. Since water is nearly equivalent to soft tissue, the results e of interest in radiology.

eutrinos

19172 THE NEUTRINO AND THE DENSITY OF MATTER IN THE UNIVERSE.

Pontekorvo [B.Pontecorvo] and Ya.Smorodinskii.
. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 239-43 (July, 1961). Russian.

The possibility that the energy density of the neutrino and anti-utrino in the universe is comparable to or greater than, the energy nsity due to the rest mass of hydrogen is considered. The assump-n of a large neutrino and antineutrino energy density is not consistent with the available experimental data. Some methods are scussed of verifying this assumption, which arises as a result of scussion of PC asymmetry of the world together with the pothesis of existence of anti-worlds. The importance of Fermi ν)(eν) interaction, which ensures the transfer of energy to the component, is emphasized. It is shown that the small magnitude the "visible" kinetic energy density (which is much smaller than e energy density due to the rest mass of the nucleons) does not ntradict the hypothesis of separation of matter from antimatter a result of fluctuations in a charge symmetric universe. The ctuation hypothesis merely requires that sometimes in the past e neutrino and antineutrino energy density exceeded the nucleon ergy density by several orders magnitude. [English translation : Soviet Physics—JETP (USA)].

HIGH ENERGY NEUTRINO PHYSICS IN COSMIC RAYS. e Abstr. 19300

19173 ON SOME PROCESSES INVOLVING HIGH ENERGY NEUTRINOS. Ya.I.Azimov and V.M.Shekhter.

. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 592-9 (Aug., 1961). Russian.

The cross-sections for processes of the type $\bar{\nu} + e^- \rightarrow \pi^- + \pi^0$, + p $\rightarrow \Lambda + \mu^+$, $\mu^- + p \rightarrow \Lambda + \nu$ are calculated by taking into account e form-factors for weak V—A coupling. [English translation in: viet Physics—JETP (USA)].

lectrons

19174 TWO-QUANTA-EXCHANGE IN THE RATIO OF THE TOTAL (e,N)-TO THE TOTAL (γ,N)-CROSS-SECTION.

.Rodenberg.
therford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C1-5, p. 147-8.

In a former theory the ratio for the total (e,N)- to the total (γ,N)-cross-section was derived in the first non-vanishing order of S-matrix-formalism, i.e. only one-virtual-quantum-exchange diagrams were included. Using the relativistic Coulomb eigenfunctions for the continuous spectrum, parts of higher order diagrams in $\alpha = e^2$ contribute to the first non-vanishing order. Calculating all the contributions of all diagrams with two-virtual-quanta-exchange to the (e,N)-cross-section in the Born approximation for electric dipole transitions, it is found that all these incoherent scattering processes amount only to 1.3% of the total Coulomb correction in the first non-vanishing order at electron energies $10 \leq E_1 \leq 300$ MeV. At higher electron energies electromagnetic and mesonic corrections to the nucleons dominate the two-quanta-exchange-effect.

19175 EMISSION OF LOW-ENERGY γ-QUANTA BY ELECTRONS SCATTERED ON PROTONS.

S.M.Bilen'kii and R.M.Ryndin.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 819-25 (March, 1961). In Russian.

It is shown that the first terms of the expansion of the amplitude in powers of the photon energy can be expressed through the electromagnetic form factors of the proton. The differential cross-section for the process is derived in this approximation. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 575-9 (Sept., 1961)].

ELECTRON POLARIZATION OPERATORS. See Abstr. 18273

ANOMALOUS MAGNETIC MOMENT OF THE ELECTRON. See Abstr. 19224

19176 SECTOR-TYPE DOUBLE-FOCUSING BETA-RAY SPECTROMETER. M.Sakai, H.Ikegami and T.Yamazaki.

Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 154-64 (Nov., 1960).

A new type of magnetic beta-ray spectrometer especially suitable for electron—gamma and electron—electron directional correlation experiments was constructed. It is a version of an ordinary sector-type double-focusing spectrometer which accepts a large solid angle. Since the spectrometer was so designed that the wall of the vacuum chamber serves as the return circuit of magnetic flux, a scintillation counter or another spectrometer can be put in the space entirely free from magnetic field. Several examples for conversion spectrum, electron—gamma coincidence spectrum and pattern of electron—gamma directional correlation are presented

19177 PROPERTIES OF POSITRONS: RESULTS OBTAINED FROM MONOCHROMATIC PHOTONS IN THE FIELD OF PHOTONUCLEAR REACTIONS.

J.Miller, C.Schuhl and C.Tzara.
J. Phys. Radium (France), Vol. 22, No. 10, 529-34 (Oct., 1961). In French.

"Nuclear physics" colloquium paper, Strasbourg, 1961 (see Abstr. 241 of 1962). The specific properties of positrons, compared to those of negatrons, permit the study of photonuclear reactions with the aid of monochromatic photons. The results obtained at Saclay by this method deal with (γ, n) reactions on various elements and the elastic scattering of photons by nuclei.

MEAN LIVES OF POSITRONS IN OXIDIZING SOLUTIONS. See Abstr. 18436

19178 KNOCK-ON ELECTRONS AND DIRECT ELECTRON PAIR PRODUCTION BY COSMIC-RAY MUONS.

P.H.Stoker, C.Hofmeyr and C.H.Bornman.
Proc. Phys. Soc. (GB), Vol. 78, Pt 5(i), 650-60 (Nov., 1961).

Knock-on electrons and direct electron pair creation by cosmic-ray muons in thin lead plates were investigated with a multiplate cloud chamber. The muons traversing the cloud chamber were classified into two energy intervals, viz. 450 to 1700 MeV and higher than 1700 MeV. By comparing the experimental results with theoretical predictions derived for the knock-on process, an effective range—energy relationship was found for electrons in lead with energies up to about 200 MeV. The experimental distributions of the knock-on production as a function of the energy transfer compare well with theoretical distributions calculated from Bhabha's formula for muons in both of these energy ranges. The comparison between the theoretical and experimental results is also satisfactory for the energy distribution for direct pair production by muons with energy above 1700 MeV. The theoretical distribution was calculated from a formula deduced anew from the differential cross-section given by Murota, Ueda and Tunaka. The experimental results favour a value between 1 and 2 for the indefinite constant α of the theory.

19179 ELECTRON AND POSITRON POLARIZATION CORRELATION IN RELATIVISTIC PAIRS.
Ya.B.Zel'dovich.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No.3(9), 912-13 (Sept., 1961). In Russian.

An electron—positron pair for which the square of the sum of the 4-momentum exceeds m_e^2 by several times consists of either a right-hand electron and left-hand positron or a left-hand electron and right-hand positron, the terms left- and right-hand pertaining to longitudinal polarization of the particles. In the c.m.s. of the pair the projection of the total spin of the pair on the direction of motion of the particle may assume only two values, +1 and −1, but not 0. The probability of processes in which this rule does not hold is $(m_e/E)^2$ times smaller than that of the "allowed" processes. [English translation in: Soviet Physics—JETP (USA)].

Nucleons

19180 ELECTROMAGNETIC EFFECTS OF THE NUCLEON SPIN—ORBIT INTERACTION. A.Arking.
Ann. Phys. (USA), Vol. 15, No. 3, 314-36 (Sept., 1961).

The nucleon spin—orbit potential is examined for its effects on electromagnetic processes of H^2, H^3, and He^3. Since only magnetic terms are affected by velocity-dependent potentials, the magnetic dipole moment operator due to the spin—orbit potential is derived and the contributions to the N—P capture cross-section and to magnetic moments of H^2, H^3, and He^3 are calculated. Only the $T = 0$ component of the spin—orbit force has any effect on these quantities. The contribution to the unpolarized capture cross-section for the Signell—Marshak (SM) and Gammel—Thaler (GT) potentials is much too small to be measured and even in a polarization measurement the effect is somewhat too small to be observed. Any hope of increasing the range and depth of the spin—orbit potential to bring agreement between theory and experiment for N—P capture must be abandoned because of the enormous contribution to the magnetic moments. The contribution to the three-body moments, −0.07 n.m. for the SM potential and −0.06 n.m. for the GT potential, is too large to be reconciled with present experimental knowledge of the magnetic moments and theoretical knowledge of the three-body wave-function and meson and relativistic effects.

19181 NUCLEON—NUCLEON INTERACTION.
G.Breit, M.H.Hull, Jr., K.E.Lassila and H.M.Ruppel.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C1/11, p. 159-60.

From the Yale phenomenological phase shift analysis, support is obtained for the pseudoscalar theory with pseudoscalar coupling and for the charge independence of nuclear forces. There is some evidence for the validity of the field theoretical scattering expansion for contributions to high orbital angular momenta L. Indications in favour of spin—orbit effects of other than PSps origin are present.

19182 INELASTIC INTERACTIONS BETWEEN 9 BeV PROTONS AND NUCLEONS.
Van Shu-fen [Wang Shu-fen], T.Vishki, I.M.Gramenitskii, V.G.Grishin, N.Dalkhazhav, R.M.Lebedev, A.A.Nomofilov, M.I,Podgoretskii and V.N.Stel'tsov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 957-60 (Oct., 1960). In Russian.

It is shown that in pp and pn interactions the angular and momentum distributions of secondary protons and pions vary little with the number of charged particles. See also following abstract. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 663-5 (April, 1961)].

19183 NUCLEON—NUCLEON INTERACTION AT AN ENERG OF 9 BeV.
I.M.Gramenitskii, I.M.Dremin, V.M.Maksimenko and D.S.Chernask
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1093-100 (April, 19
In Russian.

The pole approximation (Abstr, 7241 of 1959; 5556 of 1960) i employed to describe peripheral collisions of nucleons at 9 BeV. The results of the calculations are compared with the experimen data (Abstr. 9354 of 1960, and preceding abstract) and the agreement is found to be satisfactory. The region of applicability of th pole approximation is estimated and the possibility of obtaining information on the properties of the π-meson propagation functio and πN interaction cross-section as a function of the square of th π-meson 4-momentum (k^2) is discussed. [English translation in Soviet Physics—JETP (USA), Vol. 13, No. 4, 771-6 (Oct., 1961)].

19184 NUCLEON—NUCLEON INTERACTIONS AT AN ENER OF $E \simeq 10^{11}$ eV. I.M.Dremin and D.S.Chernavskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1333-7 (May, 1961)
In Russian.

Peripheral nucleon—nucleon collisions at an energy $E \simeq 10^{11}$ are examined. The analysis is carried out in the pole approxima (see preceding abstract). The results are compared with the experimental data (1959,1960). The single-meson approximation its usual form is found to be invalid for large "virtuality" values, k^2 (k is the 4-momentum of the intermediate π-meson) and requir improvement. The dependence of the πN-interaction cross-secti on k^2 should be taken into account. [English translation in: Sovie Physics—JETP (USA)].

19185 INTERACTION OF 5×10^{12} eV NUCLEONS WITH EMULSION NUCLEI.
N.A.Marutyan, K.A.Matevosyan and R.T.Toshyan.
Zh. eksper teor. Fiz. (USSR), Vol. 39, No. 4 (10), 993-6 (Oct., 1960). In Russian.

The energy of shower particles produced in a 6 + 31 p interaction is estimated, the primary-particle energy being 5×10^{12} eV. The mean transverse momentum is (0.17 ± 0.02) BeV/c. Th fraction of the primary-particle energy spent in the production of secondary particles is greater than 10%. The angular distributio and the transverse momentum distribution measured are compare with Landau's hydrodynamical theory. The best agreement of the transverse momentum distribution has been obtained for $kT = \frac{1}{2}\mu_{\pi}$ The nuclear interaction mean free path is of the order of 30 cm. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No 689-92 (April, 1961)].

19186 MULTIPLE PARTICLE PRODUCTION IN THE INTERACTION BETWEEN $> 10^{11}$ eV NUCLEONS AND EMULSION NUCLEI. A.P.Zhdanov, I.M.Kuks, N.V.Skirda and R.M.Yakovlev.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1177-85 (Nov., 1960). In Russian.

80 events of multiple meson production, detected in an emulsi stack, are analysed using methods of mathematical statistics. Th experimental material is compared with the hydrodynamical theor of particle production. Meson production due to central collisions between the nucleons and heavy nuclei is considered in detail. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No 819-25 (May, 1961)].

19187 QUASI-ELASTIC NUCLEON—NUCLEUS SCATTERIN AT HIGH ENERGY. R.Karplus and Y.Yamaguchi.
Nuovo Cimento (Italy), Vol. 22, No. 3, 588-603 (Nov. 1, 1961).

The angular distribution for elastic nucleon—nucleon scatteri at high energy is sharply peaked in the forward direction. As a consequence, there is an angular interval in nucleon—nucleus scattering to which successive small-angle elastic nucleon-bound nucleon scatterings are more likely to contribute than a single nucleon-bound nucleon scattering through the angle of observation Such "plural" collisions result in outgoing nucleons which have suffered a smaller energy loss than nucleons that are scattered from hydrogen at the same angle. The Fermi motion of the bound nucleons produces a broadening in the energy distribution of the scattered nucleons, but displaces the centre of the distribution onl negligibly. The results of calculations with a simple model are i satisfactory agreement with the observations on proton—carbon scattering.

19188 APPROXIMATION METHOD FOR THE DETERMINATION OF SEMI-PHENOMENOLOGICAL NUCLEON—CLEON POTENTIALS.

H.Cornille.
ovo Cimento (Italy), Vol. 21, No. 5, 773-85 (Sept. 1, 1961).
French.

A formalism is constructed connecting the phenomenological ameters of different potentials in nucleon—nucleon scattering h experimental results: phase-shifts and coupling parameters. ase-shifts are obtained by numerical calculations of two egrals, the two integrands being solutions of Volterra's coupled egral equations, whose kernels depend explicitly on the entials.

19189 AN ESTIMATION OF THE SPECTRUM OF TRUE MULTIPLICITIES IN ANTINUCLEON ANNIHILATIONS.

M.Friedländer and M.E.Mayer.
clear Phys. (Internat.), Vol. 27, No. 3, 418-20 (Oct., 1961).

A method is devised for estimating "true" multiplicities of ns in $\bar{p}$—p and $\bar{p}$—n annihilations from observed frequencies of arged prongs, on the basis of isospin and charge conservation. e procedure is illustrated by applying it to available data.

rotons

HELICITY OF THE PROTON FROM Λ DECAY. See Abstr. 16901

19190 SPACE AND CHARGE PARITIES OF A PROTON—ANTIPROTON SYSTEM AND ITS PION ANNIHILATION.

I.Shirokov.
eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 190-6 (July, 1961).
Russian.

Experiments on three and four-meson annihilation of polarized tiprotons on hydrogen are proposed which may yield the values the space and charge parities of a proton—antiprotron system. nglish translation in: Soviet Physics—JETP (USA)].

19191 DETERMINATION OF THE GYROMAGNETIC RATIO OF THE PROTON.

H.Capptuller.
. InstrumKde (Germany), Vol. 69, No. 7, 191-8 (July, 1961).
German.

The fundamental nuclear constant, the gyromagnetic ratio of e proton γ_p, was determined from the equation $\omega = \gamma_p \cdot B$ by easuring the precession-frequency ω and the applied magnetic eld B with a magnetic balance and a differential method published arlier. The results of a series of measurements in a gap of an lectromagnet with medium induction of about 0.28 Wb/m^2 is $_p = (2.675\,30 \pm 0.000\,10) \times 10^{8}\,\mathrm{m^2\,s^{-1}\,Wb^{-1}}$ (diam. correction applied) howing good agreement with the results achieved in the National ureau of Standards (Washington).

19192 FAST NEUTRONS FROM p—d COLLISIONS AT 135 MeV.

J.Esten, T.C.Griffith, G.J.Lush and A.J.Metheringham.
utherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 f 1961), Paper C 1/13, p. 163-4.

Experimental data on the angular distribution and energy spectra f fast neutrons from inelastic p—d collisions at 135 MeV are presented. These results were obtained from an analysis of cloud hamber photographs showing collisions involving either one or two rotons with energy below 10 MeV in the final state. The observed ifferential cross-sections are about twice those predicted in mpulse approximation calculations and are almost equal to the free —p values. The energy spectra have more low energy neutrons han predicted by the theory.

19193 ONE-PION EXCHANGE IN p—p COLLISIONS AT 2 BeV.

W.J.Fickinger, E.Pickup, D.K.Robinson and E.O.Salant.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 196-8 (Sept. 1, 1961).

Results of experiments on the reaction $p + p \rightarrow p + n + \pi^+$ at BeV are analysed and are found to be in general agreement with he one pion exchange model for low momentum transfer.

C.Wilkin

19194 INVESTIGATION OF AZIMUTHAL EFFECTS IN MESON SHOWERS PRODUCED BY 9 BeV PROTONS.

É.M.Fridlender.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4 (10), 965-9 (Oct., 1960). In Russian.

A statistical method is proposed for reducing the data on the azimuthal distribution of particles in low-multiplicity meson showers. It is shown that an azimuthal effect appears in showers produced by cosmic rays, but not in showers produced by 9 BeV protons. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 669-71 (April, 1961)].

19195 SEARCH FOR THRESHOLD ANOMALIES IN THE ENERGY DEPENDENCE OF THE TOTAL CROSS-SECTION FOR THE INTERACTION OF PROTONS.

I.M.Vasilevskii, Yu.D.Prokoshkin and V.I.Rÿkalin.
Zh. eksper. teor. Fiz (USSR), Vol. 40, No. 5, 1524-5 (May, 1961).
In Russian.

Both proton—proton and proton—carbon cross-sections were investigated above and below the thresholds for double pion production. The fractional deviations of the cross-sections from the mean were less than the experimental errors of 0.1% and 0.05% respectively. [English translation in: Soviet Physics—JETP (USA)].

J.E.Paton

19196 INTERACTION BETWEEN 9 BeV PROTONS AND PROTONS.

V.A.Kobzev, Yu.T.Lukin, Zh.S.Takibaev, G.R.Tsadikova and E.V.Shalagina.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 747-51 (Sept., 1961). In Russian.

The angular distributions in the c.m.s. of protons and π-mesons emitted in proton—proton collisions in photographic emulsions were measured. The proton angular distribution was symmetric and pronouncedly anisotropic. The π-meson distribution was symmetric and more isotropic. The angular dependence of the total energy in the c.m.s. was determined for protons. It is shown that on the average protons expend about 74% of their energy in the c.m.s. in meson production. Within the experimental errors the mean values of the transverse momentum and total energy in the c.m.s. are the same for various multiplicity values. [English translation in: Soviet Physics—JETP (USA)].

19197 PROTON—PROTON SCATTERING AT RELATIVISTIC ENERGIES.

H.S.Green.
Nuclear Phys. (Internat.), Vol. 27, No. 3, 405-14 (Oct., 1961).

It is shown that the cross-section for elastic p—p scattering at very high energies can be understood in terms of a hard-sphere model for the nucleon, provided the Lorentz contraction of the sphere at relativistic velocities is taken into account. The relativistic mechanics of the collision of hard spheres is discussed on the basis of classical mechanics and wave-mechanics. Already in the classical theory there is some peaking of the angular distribution in the forward direction, which is further accentuated when wave-mechanical interference effects are considered. The behaviour of the total cross-section, and the angular distribution for p—p scattering, in the energy range 0.4-8.5 GeV, is reproduced satisfactorily by the model.

19198 DE-POLARIZATION PARAMETER IN p—p SCATTERING AT 143 MeV.

L.Bird, P.Christmas, A.E.Taylor and E.Wood.
Nuclear Phys. (Internat.), Vol. 27, No. 4, 586-95 (Nov., 1961).

Measurements are reported of the Wolfenstein D-parameter in p—p scattering at 143 MeV in the angular range 30-90° (centre-of-mass). A longitudinal magnetic field was used to precess the polarization vector of the incident beam, thus largely eliminating sources of systematic error similar to those possible in the method used for measuring the asymmetries in the previous Harwell and Harvard determinations of D. The results of this re-measurement agree with the previous ones at small angles and are intermediate between the Harvard and previous Harwell values at large angles. However, since the method used is less subject to systematic error, the present results should be regarded as superseding the previous Harwell values.

19199 PHASE ANALYSIS OF pp—SCATTERING AT AN ENERGY OF 150 MeV.

I.M.Gelfand, A.F.Grashin and L.N.Ivanova.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1338-42 (May, 1961).
In Russian.

A nine-parameter phase analysis (in which the single-meson "tail" is taken into account) is applied to the experimental data on 150 MeV pp—scattering (the cross-section, polarization, depolarization and rotation of polarization) using a new numerical method (the "ravine" method). Two distinct solution regions are obtained which are similar to those previously obtained for an energy of 95 MeV. The solution found by Stabler and Lomon (Abstr. 15351 of 1960) lies in one of the regions. The results are compared with the theoretical estimations for the peripheral phase shifts. [English translation in: Soviet Physics—JETP (USA)].

19200 CORRELATION BETWEEN THE NORMAL POLARIZATION COMPONENTS IN ⌊ELASTIC⌋ pp-SCATTERING AT 650 MeV. I.

B.M.Golovin, V.P.Dzhelepov and R.Ya.Zul'karneev.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 83-8 (July, 1961).
In Russian.

The correlation coefficient between the normal polarization components (the parameter C_{nn}) was measured for the scattering angle 90°(c.m.s.). The value $C_{nn}(90^\circ) = 0.93 \pm 0.19$ was found. On the basis of the experimental values obtained the moduli of the respective amplitudes in the elastic pp-scattering matrix are calculated. [English translation in: Soviet Physics--JETP (USA)].

19201 CALCULATED ENERGY LOSSES AND RANGES OF PARTICLES IN PROPANE.

D.V.Nyagu and R.G.Salukvadze.
Rev. de Physique (Roumania), Vol. 5, No. 3-4, 415-26 (1960).
In Russian.

Energy losses and ranges of protons, π-mesons and μ-mesons in liquid propane as a function of energy are presented in the form of graphs and tables. The energy losses were derived from the data of Aron and Hoffman for hydrogen and carbon, and the ranges by numerical integration of the function $-(dE/dx)^{-1}$. The ranges were computed for energies from 1 to 1000 MeV and the proton energy losses up to 10 GeV. S.Swierszczewski

19202 ANNIHILATION OF AN ANTIPROTON—PROTON SYSTEM. É.O.Okonov.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1059-61 (Oct., 1960). In Russian.

A strong dependence of the annihilation transition matrix on the isotopic and spin states of the antiproton—proton system may significantly affect the annihilation process. In particular, a predominance of the $^1S_0$ state during annihilation may lead to an increase of the multiplicity of the π-mesons, and annihilation occurring mainly in the singlet state may inhibit two-meson annihilation. Experiments are suggested to ascertain whether such a dependence occurs in reality. It is also pointed out that an experiment can be performed to determine whether the capture of stopped antiprotons takes place from the S orbit in accordance with the estimates made for K^--mesons (Abstr. 13732 of 1969). [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 738-9 (April, 1961)].

19203 THE SUPPRESSION OF TWO-MESON ANNIHILATION IN ANTIPROTON—PROTON INTERACTION.

É.O.Okonov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1728-31 (June, 1961).
In Russian.

It is demonstrated that the suggestions made by various authors to explain the suppression of the $p + \bar{p} \rightarrow \pi^- + \pi^+$ reaction can be distinguished experimentally. Annihilation involving the emission of K-mesons is examined from the viewpoint of the various proposals and corresponding experiments are proposed. [English translation in: Soviet Physics—JETP (USA)].

Neutrons

19204 NEUTRON GAS.

J.S.Levinger and L.M.Simmons.
Phys. Rev. (USA), Vol. 124, No. 3, 916-22 (Nov. 1, 1961).

It is assumed that the neutron—neutron potential is well-behaved and velocity-dependent. Perturbation theory can then be applied to find the energy per particle of a neutron gas, in the ran of Fermi wave numbers $0.5 < k_f < 2\ f^{-1}$. The energy through fi order is found in closed form, or by a single numerical integrati Use is made of two different velocity-dependent potentials adjusted fit observed nucleon—nucleon ^1S and ^1D phase shifts. In the rang densities $0.5 < k_f < 1\ f^{-1}$, these two potentials give nearly the sa energy/particle (within 0.5 MeV); the values tend to run an MeV low values found by Brueckner et al. (Abstr. 9286 of 1960), for th Gammel—Thaler potential. Wider divergences appear at higher sities. The authors' values and Brueckner's are higher than thos found by Salpeter (Abstr. 4818 of 1961) by a semiempirical appro A crude estimate of the second-order energy for the present pote tials indicates that perturbation theory converges rapidly in the c sity range considered. The results suggest that at moderately lo densities the energy/particle in a many-body system is insensiti to the shape or nonlocal character of the assumed two-body poten

19205 ELECTRIC POLARIZABILITY OF THE NEUTRON.

A.Kanazawa and S.Tani.
Progr. theor. Phys. (Japan), Vol. 25, No. 3, 514-15 (March, 1961

Kinematical aspects of two-photon interaction are investigat The complete set of gauge and Lorentz invariant matrix elements is listed. An expression for the electric polarizability in terms the S-matrix elements is given. Vachas

19206 ISOPERIMETRIC AND OTHER INEQUALITIES IN TH THEORY OF NEUTRON TRANSPORT.

L.Dresner.
J. math. Phys. (USA), Vol. 2, No. 6, 829-47 (Nov.-Dec., 1961).

Some isoperimetric and other inequalities occurring in the o velocity theory of neutron transport are derived. The quantities volved in these inequalities all refer to bare solids with isotropic scattering and are: the critical multiplication, the first-collision probability, the non-escape probability, and the buckling. The inequalities proved provide upper and lower bounds for the quant considered, and numerous examples are given of the estimation c these quantities in cases not readily amenable to direct calculati

19207 MEASUREMENT OF ASYMPTOTIC NEUTRON SPEC IN SIMPLE WATER GEOMETRY. K.H.Beckurts.

Z. Naturforsch. (Germany), Vol. 16a, No. 6, 611-19 (June, 1961).
In German.

Describes measurements made by the time-of-flight method from scattering media. Pulsed neutrons were obtained using a 400 keV Cockcroft—Walton set and the D—T reaction. Measurements made with cubes of different dimensions enabled the effect of diffusion cooling to be estimated. R.H.Tho

19208 COMPUTATIONAL METHODS FOR ANALYSIS OF RESONANCE TRANSMISSION DATA FOR S-WAVE NEUTRONS. J.E.Lynn.

Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 3, 315-27 (Dec., 1960).

Describes computational methods that may be used for the analysis of neutron transmission data in terms of neutron resona parameters. These methods include a self-consistent scheme fo correcting the experimental data to obtain a transmission dip "a and simultaneously comparing it with the theoretical area functio to obtain a relationship between a pair of resonance parameters. Several such functional relationships (from measurement of neut transmission through different sample thicknesses) serve to fin the "best values" of the parameters the method of least square fitting. The paper includes diagrams of several families of curv describing the theoretical transmission dip area function (with a without Doppler broadening to the effective resonance cross-sec An example of the use of these methods on actual experimental d is given. It is the 66.14 eV resonance in the cross-section of U the neutron width is found to be 25.1 ± 1.2 MeV and the total radi tion width is 25.1 ± 1.4 MeV.

SOME PROPERTIES OF TRANSPORT FLUX AND CURREN AT THE SURFACE OF GREY PLATES. See Abstr. 18325

19209 ON THE EXACT THEORY OF THE SLOWING-DOWN OF NEUTRONS IN AN INFINITE HOMOGENEOUS MEDIUM. V.C.Boffi.

Nuovo Cimento (Italy), Vol. 21, No. 6, 935-57 (Sept. 16, 1961).

A study is made of the stationary energy distribution of neutrons slowed down in the medium. In particular, by confining the discussion to the field of the real variable, the following two blems are considered: (1) the existence, for any scattering and ture law, of a formally exact solution of the Boltzmann equation; the asymptotic behaviour of this solution. By assuming a con- nt scattering cross-section, some details are given for the three ictical cases of slowing down: without capture, with constant oture and with 1/v capture. For the last case, curves represent- the exact solution evaluated numerically are shown.

19210 A DERIVATION OF THE TIME-DEPENDENT ADJOINT EQUATIONS FOR NEUTRON IMPORTANCE IN THE ANSPORT, CONTINUOUS SLOWING-DOWN AND DIFFUSION DELS.

J.Lewins.

actor Sci. Technol. (GB), Vol. 13, No. 1-2, 1-5 (Oct., 1960).

A generalization of the conventional importance concept is to nsider the contribution of any one neutron to some final operation- y determinable characteristic of a nuclear reactor. Consistency quires that one neutron is as important as its progeny. From se ideas, the adjoint equations and boundary conditions are rived for the Boltzmann transport model, for simple and multi- oup diffusion theory and for the continuous slowing-down model. is more general concept for the time-dependent importance ludes the conventional expressions of iterated fission probability, . as special cases.

19211 A NUMERICAL STUDY OF THE FAST NEUTRON SPECTRUM IN HOMOGENEOUS MEDIA.

G.Rowlands.

actor Sci. Technol. (GB), Vol. 13, No. 1-2, 14-24 (Oct., 1960).

Recurrence relations from which the slowing down density as a ction of energy may be obtained by a simple step-to-step process e given. The slowing down density as a function of energy propriate to light and heavy water and carbon moderators is scussed. The effect of inelastic scattering and anisotropic elastic attering is considered and numerical values appropriate to carbon e given. Finite size effects are considered by introducing a titious absorption cross-section proportional to the geometric ckling.

19212 THE MONATOMIC GAS MODEL FOR THERMAL NEUTRON DISTRIBUTIONS IN A PHYSICAL ODERATOR.

W.W.Clendenin.

actor Sci. Technol. (GB), Vol. 13, No. 1-2, 25-34 (Oct., 1960).

Comparison of infinite medium spectra of monatomic gases th varying ratios of atomic mass to neutron mass was made and ows similarity of the spectra for low absorption and disparity r high absorption. Spectra of the scalar flux and the neutron rrent in large geometry were also computed and used to obtain e thermal neutron diffusion length of the monatomic gas. The ssibility of duplicating the scalar flux and the diffusion length of physical moderator by means of a monatomic gas of suitable mass tio is emphasized. A model of this type which reproduces the ermal neutron distribution in light water is obtained and the riation with temperature of the diffusion length of the model is mpared with experiment.

19213 THE PASSAGE OF FAST NEUTRONS THROUGH LEAD AND IRON.

.L.Broder, A.A.Kutuzov, V.V.Levin, V.V.Orlov and A.V.Turusova.

tomnaya Energiya (USSR), Vol. 7, 313 (1959). In Russian. English anslation in: Reactor Sci. Technol. (GB), Vol. 13, No. 1-2, 65-71 ct., 1960).

Results are given of measurements of the spatial distribution lead and iron of fast neutrons from sources of energies $E_0 = 4$ d 14.9 MeV and of reactor neutrons. A method of solving the oltzmann equation in media which slow down neutrons by inelastic llisions with nuclei has been developed in order to calculate the ace and energy distribution of fast neutrons at large distances om the source. The anisotropy of elastic scattering is taken into count, but the loss of neutron energy in elastic scattering is glected.

19214 THE OPTICAL PROPERTIES OF SLOW CHOPPER AND TIME-OF-FLIGHT DEVICE.

E.Maliszewski.

uclear Instrum. and Methods (Internat.), Vol. 9, No. 3, 341-6 ec., 1960).

The transmission and resolution of a slow chopper and time- f-flight device was determined experimentally and compared with eoretical curves. The shape of the neutron pulse was also easured.

FAST NEUTRON TIME-OF-FLIGHT SPECTROMETRY AND SHORT HALF-LIFE MEASUREMENTS. See Abstr. 18740

19215 ANOMALOUS REFLECTIONS IN A SINGLE-CRYSTAL NEUTRON SPECTROMETER.

V.P.Duggal, K.Raghavendra Rao, C.L.Thapar and V.Singh.

Proc. Indian Acad. Sci. A, Vol. 53, No. 2, 59-72 (Feb., 1961).

A single-crystal neutron spectrometer was used to produce mono-energetic neutron beams, the curve of count rate as a function of Bragg-angle exhibiting fluctuations of non-statistical nature which were a property of the crystal itself. Theoretical calculations showed that these were mainly caused by double Bragg reflections in the crystal, the effect of coherent inelastic neutron scattering by the crystal being extremely small. I.C.Demetsopoullos

19216 LIQUID HELIUM SCINTILLATION COUNTER AS A NEUTRON POLARIMETER.

J.E.Simmons and R.B.Perkins.

Rev. sci. Instrum. (USA), Vol. 32, No. 11, 1173-8 (Nov., 1961).

A liquid helium scintillation counter was constructed and used in analysing the spin polarization of neutrons in the range of energy near 20 MeV. Details of construction and operation of the device are described. The glass scintillation flask contains 8 moles of helium, and is supplied by a reservoir which provides 7 hr continuous operation under experimental conditions. The pulse-height spread for a source of natural alpha-particles is approximately 25%. It is found that the attenuation of the helium scintillation light in the liquid is not appreciable at a distance of 10 cm, while the wavelength is observed to be less than 1600 A. Consequently, use of a fluorescent material as a wave shifter within the helium flask is required. The intensity of the wave shifted helium light compares favourably with that from CsI(Tl). The helium counter is used in coincidence operation with a plastic scintillator neutron detector. Under these circumstances, the width of a gated helium recoil pulse-height distribution is generally less than 30%. The geometry and electronics for a typical neutron polarization experiment are described.

19217 SHORT DEAD-TIME CORONA-STREAMER COUNTER FOR NEUTRONS.

A.J.Tavendale.

Rev. sci. Instrum. (USA), Vol. 32, No. 11, 1205-8 (Nov., 1961).

The long dead-time and cathode erosion of the Rosenblum corona-spark counter for heavily ionizing radiations were overcome by forming only the streamer stage of the spark by the addition of a few percent of some diatomic gas to nitrogen-contaminated argon in corona detectors of coaxial wire—cylinder geometry. The amplitude of the streamer pulse at the anode wire is large (> 10 V) and distinctly greater than the background, with a rise-time of about 1 μsec. The recovery of the anode potential is made rapid (typically 5 μsec by a simple RC anode circuit. Efficiencies for streamer formation of 7.5% for U^{234} α-particles, 1.5% for (n, B^{10}) α's and 5% for (n, U^{235}) fission fragments were obtained in coated counters.

19218 MEASUREMENTS OF NEUTRON ENERGY BY GAS-RECOIL COUNTER.

H.Kobayashi.

Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, No. 3, 225-60 (Sept., 1960).

The gas-recoil counter is a neutron energy spectrometer designed on the basis of the collimation scheme of Giles (Abstr. 2770 of 1954). The central counter is surrounded by several counters for anticoincidence; the filling gas is hydrogen. The counter being long and thin on principle, the geometrical effective cross-sectional area facing the neutron source is small. To overcome this difficulty a multiple anode counter is proposed in which a number of counters are arranged in the form of a hive with specially devised electric circuits. Elementary experiments are made to verify the practicability of this proposed neutron spectrometer.

19219 MAGNETIC MIRRORS, CHANNELS AND BOTTLES FOR COLD NEUTRONS.

V.V.Vladimirskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1062-70 (Oct., 1960). In Russian.

It is well known that neutrons with spins oriented along a magnetic field are repelled from regions of strong field. This makes it possible to use magnetic mirrors and channels for obtaining focused beams of polarized neutrons. By surrounding an evacuated region by magnetic mirrors one can accomplish the confinement of cold neutrons. The author considers conditions of adiabaticity necessary for maintaining the orientation of the spin relative to the field, gives some possible configurations for the magnetic field, and makes estimates of the intensities of polarized beams and neutron densities in a magnetic bottle. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 740-6 (April, 1961)].

Mesons

19220 **ON SINGLE-STRANGE MESONS.**
W.Królikowski.
Nuclear Phys. (Internat.), Vol. 28, No. 1, 81-3 (Nov., 1961).

Some reactions are pointed out, in which single-strange mesons proposed previously could be observed.

19221 **WHICH IS HEAVIER: "MUONIUM ONE" OR "MUONIUM TWO"?**
L.B.Okun and B.Pontekorvo [B.Pontecorvo].
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3, 989-91 (Sept., 1961).
In Russian.

The mass difference between M_1 and M_2, the odd and even combinations of $M \equiv (\mu^+ e^-)$ and $\overline{M} \equiv (\mu^- e^+)$ are discussed in analogy with the case of neutral K-mesons. [English translation in: Soviet Physics—JETP (USA)]. J.E.Paton

19222 **ABSENCE OF μ—e CONVERSION PROCESSES AND THE $\Delta I = \frac{1}{2}$ RULE.** S.A.Bludman.
Phys. Rev. (USA), Vol. 124, No. 3, 947-52 (Nov. 1, 1961).

The lepton and strongly interacting particle currents in the universal Fermi interaction are both assumed to be split into two parts, even and odd, with respect to an internal symmetry operation. The requirement that the overall interaction be even allows $2\mu \rightarrow 2e$ processes while forbiddibg single $\mu \rightarrow e$ conversion and requires that the nonleptonic decays come about through the coupling of the strangeness-changing current with itself. This leads to a theory which differs from the schizon scheme by allowing $\Delta 2 = 2$ leptonic processes, and differs from the veton scheme by associating electrons with muon neutrinos in strangeness-changing processes.

19223 **THE STUDY OF THE ASYMMETRY IN THE DECAY OF NEGATIVE MUONS IN A NUCLEAR EMULSION.**
A.O.Vaisenberg, É.D.Kolganova and V.A.Smirnitskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1198-1200 (Nov., 1960). In Russian.

The spatial asymmetry of electrons from the $\mu^- \rightarrow e^-$ decay in NIKFI-R emulsions was studied in an 11 kOe field and in zero field. It is shown that no asymmetry can be observed in either of the cases in a total of approximately 10^4 decay events. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 834-6 (May, 1961)].

19224 **ANOMALOUS MAGNETIC MOMENTS OF THE MUON AND OF THE ELECTRON.** V.B.Berestetskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1427-9 (Nov., 1960). In Russian.

The dispersion relations and unitarity conditions yield a simple method for calculating the radiative corrections to quantum electrodynamics. A correction to the magnetic moment is calculated by taking into account the "cut-off" at high momenta. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 993-4 (May, 1961)].

19225 **DEPOLARIZATION OF μ^+-MESONS AND POLARIZATION OF Σ^+-PARTICLES IN A MAGNETIZED PARAMAGNETIC GAS.** A.M.Perelomov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1418-22 (May, 1961).
In Russian.

A formula is derived for the degree of depolarization of polarized μ^+-mesons in a paramagnetic gas located in a magnetic field. Exchange of electrons between the gas atoms and $\mu^+ e^-$ atoms is taken into account. The degree of depolarization depends on the fraction of μ^+-mesons capturing electrons, on the probability of electron exchange and on the magnetic field strength. The degree of polarization in a paramagnetic gas of Σ^+-particles which initially are unpolarized is also computed. [English translation in: Soviet Physics—JETP (USA)].

19226 **INVESTIGATION OF THE SPIN DEPENDENCE OF INTERACTION IN THE PROCESS $\mu^- + p \rightarrow n + \nu$.**
L.B.Egorov, G.V.Zhuravlev, A.E.Ignatenko, A.V.Kupstov.
L.Syuan-min [L.Hsuang-ming] and M.G.Petrashku.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 684-91 (Sept.,
In Russian.

The asymmetry coefficients of the μ—e decay electrons ave
over two hyperfine structure states, a_0, were measured by mea
of scintillation counters in mesic atoms of silver and red and b
phosphorous. The meson lifetimes $\bar{\tau}$ in these two phosphorus
modifications were also measured. The magnitude of $\bar{a}_0$ for red
(insulator) and black (conductor) phosphorus indicate in a straig
forward manner that due to the presence of conductivity electro
the meson spin relaxation time in mesic atoms becomes smalle
The values of $\bar{a}_0$ and $\bar{\tau}$ in phosphorus are employed to determine
level population in states F = 1 and F = 0 and also the probabilit
for meson capture by the nucleus in these states, λ_1 and λ_0. The
values directly indicate that $\lambda_1 \neq \lambda_0$ (weak interaction is spin
dependent) and $\lambda_0 > \lambda_0$ (capture takes place more rapidly from
F = 0 state than from the F = 1 state). The lower limit obtained
for the quantity is direct evidence that the interaction is of the
type A—xV. [English translation in: Soviet Physics—JETP (US

19227 **SCATTERING OF 1-5 BeV/c μ-MESONS IN LEAD.**
S.A.Azimov, G.G.Arushanov, Kh.Zainutdinov, R.Kar
V.S.Masagutov and M.Kh.Ésterlis.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 56-9 (July, 196
In Russian.

Scattering in 2 cm thick lead plates located in a cloud cham
was studied. The experimental results are in good agreement w
the multiple-scattering theory of Cooper and Rainwater (Abstr.
of 1955), in which the finite size of the nucleus is taken into acc
[English translation in: Soviet Physics—JETP (USA)].

19228 **ANGULAR DISTRIBUTION OF μ-MESONS IN π—μ DECAY.**
A.O.Vaisenberg, É.D.Kolganova and Z.V.Minervina.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 106-8 (July, 196
In Russian.

It is shown that the angular distribution of μ-mesons emitte
the decay of π-mesons produced in strong interactions is isotro
Deviations from isotropy observed in certain cases may be due
the omission of some of the π—μ decays when their density is ve
high. Emulsion and microscope distortions are shown to have n
effect on the angular distribution. [English translation in: Sovie
Physics—JETP (USA)].

19229 **ON THE ELECTROMAGNETIC FORM-FACTOR OF THE π^0-MESON.**
Syan'Din-chan [Hsien Ding-chang] and Khu Shi-ké [Hu Shih-ke].
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 600-2 (Aug., 19
In Russian.

It is shown that the electromagnetic form-factor of the π^0-m
can be determined in the process $e^+ + e^- \rightarrow \pi^0 + \gamma$. [English tra
lation in: Soviet Physics—JETP (USA)].

19230 **RADIATIVE CORRECTION IN π-MESON DECAYS.**
Ya.A.Smorodinskii and Khu Shi-ké [Hu Shih-ko].
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 612-15 (Aug., 1
In Russian.

Radiative corrections to pion decays are calculated. The s
of real photons emitted together with μ-mesons and electrons a
different in shape. Thus for a given cut-off of the photon spectr
in each of the channels, the ratio of the decay probabilities depe
essentially on the cut-off value. On the other hand, the contribu
of radiation effects to the total decay probability (decay with
emission of any photon) is 3.93%. This correction is primarily
determined by the ratio of photon emission by the electron and
μ-meson. Expressions are given for the lepton and photon spec
in π-decays. [English translation in: Soviet Physics—JETP (US

19231 **DOUBLE DISPERSION RELATIONS AND THE PHOT PRODUCTION OF π-MESONS. II.**
N.F.Nelipa and V.A.Tsarev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1710-12 (June, 19
In Russian.

For Pt I, see Abstr. 16852 of 1961. An approximation of th
contribution of annihilation of a nucleon pair into a π-meson and
γ-quantum to the π-meson photoproduction amplitude is made by
applying the integral equations derived in Pt I. [English transla
in: Soviet Physics—JETP (USA)]

232 COHERENT AND INCOHERENT NUCLEAR π^0 PHOTOPRODUCTION. S.M.Berman.

'o Cimento (Italy), Vol. 21, No. 6, 1020-7 (Sept. 16, 1961).

A simple treatment of π^0 photoproduction in complex nuclei, g closure and neglecting nuclear absorption of the π^0, is con- red in the region of small momentum transfer. In addition to ısual incoherent process in a nucleus the fact that the nucleon hich the π^0 is produced does not change its charge gives rise to ɔossibility of a coherent addition of the production amplitude the whole nucleus provided the momentum transfer to the eon is not large compared to the inverse nuclear size. Because spin independent part of the production amplitude which is re- ısible for the coherent process has a sin θ dependence (θ is the e between pion and photon), the coherent cross-section will sh in the forward direction and will reach a maximum at an angle = (1.87) $[Kr_0A^{1/3}]^{-1}$, where K is the photo momentum and $r_0A^{1/3}$ charge radius of the nucleus. Due to the fact that the maximum s not occur at zero angle the ratios of the coherent cross- ion at θ_m will behave as $A^{4/3}$ rather than A^2 in different nents. An estimate of the incoherent process is included and it hown that this cross-section is less than the sum of A free eons for small momentum transfers and reaches the free nucleon ıe as the momentum transfer approaches the Fermi momentum.

PRODUCTION OF PIONS IN PROTON—CARBON INTER- TIONS. See Abstr. 19195

19233 EQUATIONS FOR PHOTOPRODUCTION OF PIONS ON NUCLEONS WITH EFFECTS DUE TO A PION—PION ERACTION TAKEN INTO ACCOUNT.

.Solov'ev, G.Byalkovski [Bialkowski] and A.Yurevich [Jurewicz].
eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 839-47 (March, 1961).
ussian.

Equations for the partial wave amplitudes for photoproduction ions on nucleons at low energies are derived from the Mandel- n representation (Abstr. 4941 of 1959) in the Cini—Fubini roximation (Abstr. 15276 of 1960). Nucleon recoil and pion— interaction are taken into account. The latter contributes only he isotopic scalar photoproduction amplitudes. Expressions these amplitudes, with effects of pion—pion interaction included, obtained. [English translation in: Soviet Physics—JETP (USA), . 13, No. 3, 589-94 (Sept., 1961)].

19234 SINGLE-MESON CONTRIBUTION TO THE PHOTOPRODUCTION OF π^--MESONS ON PROTONS.

.Laperashvili and S.G.Matinyan.
eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 272-5 (July, 1961).
ussian.

Quantitative agreement between Drell's theory (Abstr. 20095 of 0; 439 of 1961) and experimental results can be obtained by ing into account the correction suggested by the Salzmans str. 17404, 20194 of 1960). [English translation in: Soviet ysics—JETP (USA)].

19235 ANALYSIS OF THE DISTRIBUTIONS OF TRANSVERSE MOMENTA OF π-MESONS AND STRANGE RTICLES. N.N.Roinishvili.

eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 919-23 pt., 1961). In Russian.

The experimental distributions of the transverse momenta of nesons and strange particles are analysed on the basis of ious theoretical models. According to the quasi one-dimen- nal hydrodynamic theory π-mesons and strange particles should emitted at the same temperature $kT \cong m_\pi c^2$, whereas according the field theory, the radius of the region of π-meson production uld be approximately twice the size of the region of hyperon K-meson emission. [English translation in: Soviet Physics— TP (USA)].

19236 THE MATRIX ELEMENT OF THE REACTION $\pi + N \rightarrow \pi + \pi + N$ AT LOW ENERGIES.

Zav'yalov and V.P.Pavlov.
kl. Akad. Nauk SSSR, Vol. 139, No. 1, 79-82 (July 1, 1961).
Russian.

For abstract, see Abstr. 16861 of 1961. [English translation in: viet Physics—Doklady (USA), Vol. 6, No. 7, 595-7 (Jan., 1962)].

THE MASS AND WIDTH OF THE J = 1, T = 1, $\pi\pi$ RESONANCE. e Abstr. 19141

19237 PRODUCTION OF π^0-MESONS IN COLLISIONS BETWEEN 2.8 BeV/c π^--MESONS AND PROTONS.

Ya.Ya.Shalamov and V.A.Shebanov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1232-6 (Nov., 1960). In Russian.

The production of π^0-mesons in the $\pi^- + p \rightarrow m\pi^0 + n$ (m = 1, 2, 3) reactions was investigated at $p(\pi^-)$ = 2.8 BeV/c in a 17 litre bubble chamber filled either with a propane—xenon or a Freon 12—Freon 13 mixture. The cross-section for hydrogen was determined by the difference method as (2.2 ± 0.3) mb. The mean number of γ-rays per interaction is 4.0 ± 0.4. The angular distribution of the γ-rays in the c.m.s. is anisotropic and possesses a sharp peak in the forward direction. The small cross-section for exchange scattering, $\sigma(\pi^- + p \rightarrow \pi^0 + n)$ = (0.20 ± 0.25) mb, indicates that, for the given π^--meson energy, the partial interaction cross-sections with isotopic spins $\frac{3}{2}$ and $\frac{1}{2}$ are equal. The cross-sections for processes involving the production of two or three π^0-mesons are estimated by analysing the distribution of the events with respect to the number of γ-quanta. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 859-62 (May, 1961)].

19238 KINEMATIC STUDY OF THE ELECTRO-PRODUCTION OF π-MESONS. P.Kessler.

J. Phys. Radium (France), Vol. 22, No. 6, 388-9 (June, 1961).
In French.

Valid for the production of π-mesons by any sufficiently relativistic particle.

J.E.Paton

19239 INTERACTION OF π-MESONS IN THE FERMI STATISTICAL THEORY. V.S.Barashenkov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1313-15 (May, 1961).
In Russian.

The energy spectra of π-mesons and nucleons produced in inelastic NN-collisions at an energy E = 9 BeV are calculated under the assumption of $\pi\pi$-interaction. The results of the calculations are compared with experiment. [English translation in: Soviet Physics—JETP (USA)].

19240 ELECTROMAGNETIC INTERACTIONS OF CHARGED PIONS. Bibhuti Bhusan Deo.

Nuclear Phys. (Internat.), Vol. 28, No. 1, 122-34 (Nov., 1961).

Perturbation calculation results of electromagnetic effects involving charged mesons are reported. The pionic vacuum contribution to photon—photon scattering and Delbrück forward scattering are discussed in detail.

19241 A REDETERMINATION OF THE PANOFSKY RATIO. V.T.Cocconi, T.Fazzini, G.Fidecaro, M.Legros, N.H.Lipman and A.W.Merrison.

Nuovo Cimento (Italy), Vol. 22, No. 3, 494-518 (Nov. 1, 1961).

The Panofsky ratio was measured using an NaI(Tl) γ-ray spectrometer. The accuracy is limited by the statistical error and not by the resolving power of the spectrometer or by other sources of systematic errors. The final result is P = 1.533 ± 0.021.

19242 A THEORETICAL APPROACH TO HIGH-ENERGY PION PHENOMENA.

D.Amati, S.Fubini, A.Stanghellini and M.Tonin.
Nuovo Cimento (Italy), Vol. 22, No. 3, 569-87 (Nov. 1, 1961).

A theoretical analysis is made of the main features of high-energy strong interactions. First of all, by applying dispersion theory to the elastic scattering amplitude for high-energy and low-momentum transfer, expressions are obtained for the shape of diffraction scattering and for the total cross-sections. The form of those results has suggested a definite model for the most important inelastic processes. In this model a well-defined group of Feynman graphs, the "most peripheral" ones, gives the dominating effect in high-energy collisions.

19243 FORM FACTORS AND VECTOR MESONS.

M.Gell-Mann and F.Zachariasen.
Phys. Rev. (USA), Vol. 124, No. 3, 953-64 (Nov. 1, 1961).

The 2π and 3π resonances are re-examined from the point of view that they are vector mesons coupled to conserved currents. The theory of unstable mesons is discussed and formulae are then derived for the emission and propagation of these mesons. The connection with electromagnetic form factors is then given, particularly for the simple case of infinite bare mass. The results are very similar to those of the dispersion method. Experimental manifestations of universality (connected with the conserved vector current) are discussed. Applications are then made to the decay of π^0 and a group of related phenomena, including several "pole" experiments. Also, the contribution of the 2π resonance to π—N scattering is discussed briefly from the vector meson point of view. Finally, the vector meson approach is compared to the alternative method using dispersion relations applied to presumably dynamical resonances. It is concluded that the dynamical picture is an interesting special case of the vector meson theory with infinite bare mass, a case in which the mass and coupling constant are determined and the behaviour at high energies is less singular. The methods developed are applicable to the dynamical case.

19244 INELASTIC INTERACTION OF 7 BeV NEGATIVE PIONS WITH NUCLEONS. V.A.Belyakov, Van Shu-fen [Wang Shu-fen],V.V.Glagolev, N.Dalkhazhav, R.M.Lebedev, N.N.Mel'nikova, V.A.Nikitin, V.Petrzhilka, V.A.Sviridov, M.Suk and E.D.Tolstov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 937-47 (Oct., 1960). In Russian.

535 π^-N interactions in emulsion are analysed for ~7 BeV mesons. A large asymmetry is observed in the c.m.s., with the nucleons predominantly emitted in the backward hemisphere. Moreover, the transverse and longitudinal momenta of the emitted nucleons are found to be independent of the number of secondary charged particles. The fast pions are characterized by a considerable anisotropy in the angular distribution, whereas slow mesons are emitted isotropically (in the πN c.m.s). The average momentum of the fast pions is equal to that of the protons. The total number of pions produced does not depend strongly on the number of concurrently produced charged particles. The multiplicity distribution and the average multiplicity can be made consistent with the statistical theory, but the angular and momentum distributions (particularly for nucleons) contradict the theory. An attempt is made to estimate the upper limit of the radius of the nucleon core. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 650-6 (April, 1961)].

19245 π—p-INTERACTION AT AN ENERGY OF 7 BeV. I.M.Gramenitskii, I.M.Dremin and D.S.Chernavskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 856-60 (Sept., 1961). In Russian.

The method previously developed (Abstr. of 1961) is employed to describe π^-—p-interaction at an energy of 7 BeV. The results of the calculations are compared with the experimental data (see preceding Abstract). The comparison shows that the main characteristics of recoil nucleons (their energy spectrum, angular distribution etc.) satisfactorily agree with the calculations. The problem of obtaining information on π—π-interaction at energies for which it is mainly inelastic and in particular on the diffractional π—π-interaction cross-section is discussed. It is shown that suitable events can be chosen from the experimental material on π^-—p-interaction and used for determining the diffractional π—π-interaction cross-section. [English translation in: Soviet Physics—JETP (USA)].

19246 DETERMINATION OF THE PION—NUCLEON COUPLING CONSTANT FROM DIFFERENTIAL CROSS-SECTIONS FOR ELASTIC n—p SCATTERING. N.S.Amaglobeli, Yu.M.Kazarinov, S.N.Sokolov and I.N.Silin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 948-53 (Oct., 1960). In Russian.

Experimental data on n—p scattering at 90, 380-400 and 630 MeV are analysed for the purpose of determining the pion—nucleon coupling constant, assuming that two poles exist in the real part of the n—p scattering amplitude. It is shown that within the experimental error the available data do not disagree with $f^2 = 0.08$. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 657-60 (April, 1961)].

19247 A RESONANCE MODEL FOR THE REACTIONS $N + \pi \rightarrow N + \pi + \pi$ AND $\gamma + N \rightarrow N + \pi + \pi$. V.V.Anisovich.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1357-62 (Nov., 1960). In Russian.

The reaction $N + \pi \rightarrow N + \pi + \pi$ for 300 to 550 MeV incident mesons and the reaction $\gamma + N \rightarrow N + \pi + \pi$ for 450 to 700 MeV γ-quanta are studied phenomenologically. It is shown that a simple model, according to which the production of a meson in meson—nucleon collisions proceeds mainly via the transition $D_{3/2} \rightarrow P_{3/2}S_{3/2}$, is in agreement with all available experimental data. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 94 (May, 1961)].

19248 DETERMINATION OF THE π-MESON—NUCLEON COUPLING CONSTANT FROM THE DIFFERENTIA CROSS-SECTIONS FOR ELASTIC pp-SCATTERING. Yu.M.Kazarinov, V.S.Kiselev, I.N.Silin and S.N.Sokolov.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 197-8 (July, 1 In Russian.

The pp-scattering cross-sections at energies of 147, 330 a 380 MeV are employed to determine the πN-coupling constant f The results obtained for $E_p = 147$ and 380 MeV are consistent a value of $f^2 = 0.08$. It is not possible to make the cross-sectio 330 MeV agree with the value $f^2 = 0.08$. [English translation in Soviet Physics—JETP (USA)].

19249 APPLICATION OF THE POLE METHOD FOR ANA OF THE EXPERIMENTAL DATA ON π—p INTERACTIONS. V.I.Rus'kin, and D.S.Chernavskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 629-32 (Aug., 1 In Russian.

Various kinematic characteristics of the process $\pi + N \rightarrow \rightarrow \pi + \pi + N$ are examined. On this basis, a method is propose separating events due to the pole diagram considered by Chew a Low (Abstr. 7241 of 1959), from other events. The problem of improving the extrapolation procedure of Chew and Low is discu [English translation in: Soviet Physics—JETP (USA)].

19250 THE ANALYTIC PROPERTIES OF THE TOTAL π— INTERACTION CROSS-SECTION AS A FUNCTION O VIRTUALITY. I.M.Dremin.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 821-7 (Sept., 19 In Russian.

The analytic properties of the imaginary part of the amplitu for elastic scattering of π-mesons on nucleons through an angle 0° as a function of virtuality (i.e. square of 4-momentum) of the pion is considered by perturbation theory as well as on the basis the Jost—Lehmann—Dyson spectral representation. In virtue of optical theorem, such an analysis yields information on the analy properties of the total π—N interaction cross-section as a functi of virtuality. The role of "anomalous" thresholds is indicated. T possibility is discussed of a multiplicative character of the total cross-section as a function of the total energy in the c.m.s. and virtuality. [English translation in: Soviet Physics—JETP (USA)

19251 A SIMPLE MODEL FOR TWO-CHANNEL REACTIO IN FIELD THEORY AND ITS APPLICATION TO THE Y* PROBLEM. Y.Fujii.
Progr. theor. Phys. (Japan), Vol. 26, No. 3, 391-417 (Sept., 1961

A simple two-channel model in field theory is presented in order to study characteristic features of the problems concernin the Y* particle ($\pi\Lambda$ excited state). Four particles, K_-, N, π an all assumed to be spinless, are considered, and the S-state amplitudes are calculated in the chain approximation. The calcu amplitudes satisfy the unitarity condition and reproduce bound states, resonances, and other features of the reactions. From th examples treated it is concluded that a strong attractive force between K_- and N, such that there is a bound state and a weak coupling between K_-N and $\pi\Lambda$ channels, is essential for the appe ance of a sharp peak both in the K_-N total cross-section and the $K_- + N \rightarrow \pi + \Lambda$ cross-section in the unphysical region. The rel between height and width is such that the peak tends to a δ-funct if the width tends to an infiniesimal. This conclusion remains u changed even if a force between π and Λ is varied over a wide ra According to the variety of $\pi\Lambda$ force, the $\pi\Lambda$ cross-section exhib either a peak or a dip near the energy at which the K_-N total cro section exhibits a peak. Furthermore an attractive or a repuls $\pi\Lambda$ force contributes to make the peak broader or narrower, respectively.

19252 A NEUTRAL MODEL FOR INVESTIGATION OF π—π SCATTERING.
A.V.Efremov, Chzhu Khun-yuan' [Tzu Hung-yuan] and D.V.Shirko
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 603-11 (Aug., 19 In Russian.

An equation describing the scattering of low energy neutral pseudoscalar mesons is investigated. A general solution of the equation is derived which is similar to that obtained by Castillej Dalitz and Dyson (Abstr. 2676 of 1956), for the Low equation. T

rent types of asymptotic behaviours of the solutions at high
gies are possible. If the amplitude decreases as $(\ln E)^{-1}$ at
energies, the solution corresponds to the renormalizable
urbation theory. In the second case when the amplitude decrease
$^{-4}$ the solution does not correspond to perturbation theory. In a
ain sense it can be connected with the nonrenormalizable
rangian $[(\partial\varphi/\partial x_n)\ (\partial\varphi/\partial x_n)]^2$. This second solution possesses
e interesting properties. In particular it becomes degenerate
n the interaction is switched off. [English translation in:
et Physics—JETP (USA)].

19253 OFF-SHELL PION—NUCLEON SCATTERING AND DISPERSION RELATIONS.

E.Ferrari and F.Selleri.
vo Cimento (Italy), Vol. 21, No. 6, 1028-44 (Sept. 16, 1961).

The problem of pion—nucleon scattering when one of the pions
irtual is discussed. By assuming that one-dimensional disper-
relations in the energy variable can be written for suitably de-
d invariant amplitudes, and that also in the off-shell case the
ersive integrals are dominated by the $T = J = \frac{3}{2}$ amplitude, an
nès-type integral equation is deduced for this amplitude. The
rous solution of this equation is discussed and reduced to an
roximate simpler form which is more suitable for numerical cal-
ations. This form is particularly simple for squared four-
nenta of the virtual pion less than ~ 5 squared pion masses.

19254 ELASTIC π^-—p SCATTERING AT 1.4 BeV.

S.Minami.
gr. theor. Phys. (Japan), Vol. 26, No. 3, 375-80 (Sept., 1961).

Experimental results for π^-—p collisions at 1.4 BeV are
lysed taking into account the effects of real parts of the scatter-
amplitude. It is shown that the approximation in which the real
ts of the phase shifts are neglected is not necessarily good.

19255 π—π RESONANCE IN π^-—p INTERACTIONS AT 1.25 BeV.

E.Pickup, D.K.Robinson and E.O.Salant.
ys. Rev. Letters (USA), Vol. 7, No. 5, 192-5 (Sept. 1, 1961).

Experiments on one-pion production in π^-—p scattering are
lysed on the basis of the one-pion exchange model. Satisfactory
eement with this model is obtained by studying the cross-section
a function of the nucleon momentum transfer. The cross-
tion for π—π scattering deduced from these experiments shows
esonance at a Q value of 475 ± 10 MeV with a half-width at half
ximum of 65 MeV, which is in reasonable agreement with the
lier work at Erwin et al. (Abstr. 12103 of 1961). C.Wilkin

19256 PION—NUCLEON SCATTERING AT LOW ENERGIES. II.

.Efremov, V.A.Meshcheryakov and D.V.Shirkov.
. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1099-1105
t., 1960). In Russian.

On the basis of results given in Pt I (Abstr. 20202 of 1960), an
egral equation for the α_{33} phase shift is obtained along with
ressions for the other phase shifts, which involve the π—π
ttering phase shifts δ_0 and δ_1. The important role of the disper-
n relations for backward pion—nucleon scattering is established.
s shown that the δ_0 phase shift greatly influences the π-N scatter-
. The scattering length for the δ_0 phase shift is determined by an
lysis of small p phase shifts near the π-N scattering threshold.
nglish translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4,
6-70 (April, 1961)].

19257 BACKWARD ELASTIC SCATTERING OF 2.8 BeV/c π^--MESONS ON NEUTRONS.

Yu.D.Bayukov,
A.Leksin, D.A.Suchkov, Ya.Ya.Shalamov and V.A.Shebanov.
. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 52-5 (July, 1961).
Russian.

Quasielastic π^-n scattering towards the rear hemisphere in the
oratory coordinate system was investigated in a 17 litre freon
amber. The cross-section of the process per F nucleus was
und to be < 0.1 mb. Recalculated for a free nucleon, the total
n elastic-scattering cross-section is found to be smaller than
02 mb for angles between 140° and 180° in the c.m.s. Comparison
this result with the theoretical estimations of the contribution of
single virtual nucleon diagram to the scattering indicates that
e diagram is compensated by more complex diagrams. [English
anslation in: Soviet Physics—JETP (USA)].

19258 LIMITING VALUES OF THE $\pi^\pm$p SCATTERING AMPLITUDE.

V.P.Kanavets, I.I.Levintov and B.V.Morozov.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 146-53 (July, 1961).
In Russian.

Dispersion relations in which subtraction is transferred to points located at infinity are derived on the basis of Pomeranchuk's assumptions regarding the asymptotic behaviour of the scattering amplitude (Abstr. 8219 of 1958). In this form the dispersion relations are most convenient for estimating the asymptotic behaviour of the amplitude on basis of the experimental data on $\pi^\pm$p scattering. A preliminary numerical estimation of the asymptotic behaviour of the $\pi^\pm$p scattering amplitude is presented. The question whether the validity of the dispersion equations at high energies is consistent with the statistical theory is considered. [English translation in: Soviet Physics—JETP (USA)].

19259 INTEGRAL EQUATIONS FOR $\pi\pi$-SCATTERING AND PROBLEMS RELATED TO CONVERGENCE OF THE AMPLITUDE EXPANSION.

Ya.Fisher [J.Fischer] and S.Chulli [S.Ciulli].
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 256-62 (July, 1961).
In Russian.

Convergence of the expansion of the cosine dependence of the amplitude employed in the deduction of the integral equations from the Mandelstam representation is investigated in the case of $\pi\pi$-scattering. An equation set for low energies is presented in which rapid convergence of the expansion of the real part of the amplitude can be attained by a conformal mapping of the cosine plane. Since any power of the function employed contains an infinite number of partial waves this approach should be especially convenient in those cases when high number waves may be important. [English translation in: Soviet Physics—JETP (USA)].

19260 THRESHOLD SINGULARITIES IN TOTAL PION SCATTERING CROSS-SECTION.

N.P.Klepikov, V.R.Rokityanskii, Yu.G.Rudoi, F.V.Saevskii, V.V.Fedorov and V.A.Yudin.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 937-8 (Sept., 1961).
In Russian.

An analysis of the experimental data indicates the possible existence of singularities in the total cross-section for π^+-meson scattering near the thresholds for production of an additional pion. [English translation in: Soviet Physics—JETP (USA)].

19261 EXPERIMENTAL VERIFICATION OF THE $\Delta I = \frac{1}{2}$ SELECTION RULE FOR LEPTON DECAY OF K-MESONS.

D.V.Nyagu, É.O.Okonov, N.I.Petrov, A.M.Rozanova and V.A.Rusakov.
Zh. eksper. teor. Fiz. (USA), Vol. 40, No. 6, 1618-24 (June, 1961).
In Russian.

The relative probability for the decay $K_2^0 \to e^\pm + \pi^\mp + \nu$ was measured with a cloud chamber containing a lead plate. With respect to all decays yielding charged products, this probability is $(46 \pm 11)\%$. Four electron—positron pairs with large scatter angles were found and analysed. It is shown that these events should be considered as a direct experimental indication of the hitherto unobserved $K_2^0 \to 3\pi^0$ decay. Within the experimental errors, the absolute probability of the $K_2^0 \to e^\pm + \pi^\mp + \nu$ decay determined from the mean lifetime of the K_2^0-meson is consistent with the twofold absolute probability for $K^+ \to e^+ + \pi^0 + \nu$ decay. This indicates the feasability of extending the selection rule $\Delta I = 1/2$ to K-meson leptonic decays. An estimation of the absolute probability for $K_{\mu 3}$-decay is also consistent with the aforementioned selection rule. [English translation in: Soviet Physics—JETP (USA)].

19262 $K^+ \to \pi^+ + \pi^0 + e^+ + e^-$ DECAY.

I.G.Ivanter.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 244-6 (July, 1961).
In Russian.

Considered without taking into account interaction after decay. The distributions in the effective mass of the two π-meson system is derived. A new approximate method has been applied to compute the integrals of the bremsstrahlung probability density over the phase space in the presence of the two very light particles among the four. [English translation in: Soviet Physics—JETP (USA)].

19263 DETERMINATION OF THE $K^+ \to 2\pi + \gamma$ DECAY AMPLITUDE FROM THE DISPERSION EQUATIONS AND UNITARITY CONDITIONS.

I.G.Ivanter.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 773-83 (Sept., 1961). In Russian.

The effect of $\pi-\pi$-interaction on the amplitude of radiative θ^+-decay is taken into account. An expression for the amplitude is obtained in terms of the p-phase shift of $\pi-\pi$-scattering. The Omnes—Muskhelishvili method of solving the integral equations (Abstr. 3630 of 1958) is extended to the case when the inhomogeneous part of the equation is a singular function. [English translation in: Soviet Physics—JETP (USA)].

19264 τ-DECAY AND $\pi-\pi$-COUPLING.

Yu.Vol'f and V.Tsellner.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 835-41 (Sept., 1961). In Russian.

Integral equations for the probability of τ-decay are derived. An effective range analysis gives s-wave scattering lengths for the $\pi-\pi$ interaction which reproduce the experimental τ-decay spectrum. Satisfactory agreement with experiment is obtained for $a_2 \cong 0.2$ and $a_0 \cong -0.3$. In conjunction with the integral equations for $\pi-\pi$ scattering, these values speak in favour of the existence of a $(T = 2)$ resonance in $\pi-\pi$ interaction. [English translation in: Soviet Physics—JETP (USA)].

19265 TOTAL CROSS-SECTIONS FOR THE INTERACTION OF 4.75 AND 3.7 BeV/c K^+ AND π^+-MESONS WITH PROTONS AND NUCLEI.

M.F.Likhachev, V.S.Stavinskii, Syui Yuin-chan [Hsü Yün-ch'ang] and Chzhan Nai-sén [Chang Nai-sên].

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1(7), 38-41 (July, 1961). In Russian.

The following values were obtained: 21.3 ± 4.6 and 21 ± 4.3 mb for K^+-mesons; 33.3 ± 1.3 and 30 ± 1.2 mb for π^+-mesons; the momenta being respectively, 4.75 ± 0.15 and 3.7 ± 0.1 BeV/c. Data on the cross-sections for the inelastic collisions of K^+ and π^+-mesons with C, Al, Cu, Sn and Pb nuclei were also obtained. [English translation in: Soviet Physics—JETP (USA)].

19266 K MESON—PION INTERACTION AND $\bar{K}^- + p \rightarrow K^0 + \pi^- + p$ REACTION.

S.Minami.

Progr. theor. Phys. (Japan), Vol. 26, No. 3, 356-74 (Sept., 1961).

The $\bar{K}-\pi$ interaction is studied by taking into account the effects of K^*. Both the value of the coupling constant for the $\bar{K}\pi K^*$ interaction and the magnitude of the cross-section of $\bar{K}-\pi$ scattering are estimated under the assumption that the isotopic spin of K^* is equal to $\frac{1}{2}$. The value of the coupling constant is used to investigate the reaction $K^- + p \rightarrow K^0 + \pi^- + p$ at 1.15 and 2 BeV/c. The total cross-section of this reaction, the angular distributions and momentum spectra of protons and pions are examined. It is shown that the assumption of $S = 1$ (S indicates the spin of K^*) rather than that of $S = 0$ is consistent not only with the experimental results for the angular distribution of the $K^- + p \rightarrow K^* + p$ process but also with those for the $K^- = p \rightarrow \bar{K}^{0*} + \pi^- + p$ reaction at 1.15 BeV/c, that is, for the magnitude of the cross-section and the energy spectrum of the pions.

19267 EMISSION OF FAST DEUTERONS AND TRITONS FROM K^--MESONS CAPTURED AT REST IN NUCLEAR EMULSION AND A SEARCH FOR THE HYPERNUCLEUS $(\Sigma^- n)$.

D.Evans, B.D.Jones B.Sanjeevaiah, J.Zakrzewski, M.J.Beniston, V.A.Bull, D.H.Davis W.B.Lasich, N.N.Raina, M.Amerighi, M.di Corato, A.Fedrighini, A.Sichirollo and G.Vegni.

Nuovo Cimento (Italy), Vol. 21, No. 5, 740-6 (Sept. 1, 1961).

The results of mass measurements on the fast baryons emitted in the capture at rest of 7600 K^--mesons are described. The analysis was restricted to those interactions from which neither charged π-mesons, nor slow Σ-hyperons (kinetic energy ≤ 60 MeV), nor hyperfragments are emitted. As reported (Abstr. 8500 of 1961), a substantial number of deuterons and tritons are present among the fast baryons; the proportion of deuterons of kinetic energy exceeding 84 MeV is (11.1 ± 2.5)%, that of tritons is (2.3 ± 1.0)%. Fast deuterons and tritons of ranges greater than 1 cm are emitted from at least (1 ± 0.2)% of K^--meson interactions at rest in nuclear emulsion. Among the fast baryons a number of Σ-hyperons decaying in flight were observed and measured; no $(\Sigma^- n)$ hypernucleus was detected.

19268 SCATTERING OF K-MESONS ON NUCLEONS AT LARGE ORBITAL MOMENTA.

Yu.P.Nikitin.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1856-8 (June, 1961). In Russian.

Peripheral KN-scattering is investigated by taking into account only 2π-meson exchange. The KN-scattering phase-shifts are expressed in terms of the $K\pi$-coupling constant. A phase-shift analysis of experimental data on KN-scattering, in which high p shifts $(l > \sim 2)$ are taken into account in principle, may yield in ation on the magnitude of the $K\pi$-interaction. The contribution the single-hyperon diagram to the KN-scattering phase shift is discussed. [English translation in: Soviet Physics—JETP (USA

19269 GLOBAL SYMMETRY AND THE CONSERVATION O ISOBARIC SPIN IN NON-LEPTONIC HYPERON DECAYS.

G.Takeda and M.Kato.

Atomnaya Energiya (USSR), Vol. 6, 556 (1959). In Russian. En translation in: Reactor Sci. Technol. (GB), Vol. 13, No. 1-2, 51-6 (1960).

The possible existence of a universal V—A interaction and global symmetry in non-leptonic hyperon decay is discussed. Deviations from the expected symmetry, which occur in actual decays, are explained in terms of the meson structure of the hyperons. A new isobaric spin is defined, equal to 1/2 for all baryons and to 0 or 1 for K-mesons. It is closely connected wit the idea of global symmetry, and is conserved in non-leptonic d

19270 PRODUCTION OF Y^0 (Λ, Σ^0) AND K^0-PARTICLES C LIGHT NUCLEI BY 2.8 BeV/c π^--MESONS.

Ya.Ya.Shalamov, V.A.Shebanov and A.F.Grashin.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1302-12 (May, 19 In Russian.

The production of Y^0 (Λ, Σ^0) hyperons and K^0-mesons by 2.8 BeV/c π^--mesons on light nuclei was studied in a freon $(C_2F_5Cl_3)$ bubble chamber. The Y^0- and K^0-production cross-sec were respectively (2.5 ± 0.5)% and (7 ± 1)% of the total cross-section for inelastic processes. From 143 $(Y^0 + K^0)$ and $(K^0 + \bar{K}^0)$ pr tion events the cross-sections for these processes were determ as well as the angular and momentum distributions of the produ particles. The ratio of the cross-sections was $\sigma(K^0\bar{K}^0)/\sigma(Y^0K^0)$ $= 0.65 \pm 0.15$ and their sum was $\sigma(K^0\bar{K}^0) + \sigma(Y^0K^0) = (3.2 \pm 0.8)\%$ o the total cross-section for inelastic processes. In 80-90% of th events an elementary $Y^0 + K^0$ production act was accompanied by generation of a π-meson but in 70-80% of $K^0 + \bar{K}^0$ production act no additional π-meson was emitted. A characteristic feature wa that, in $K^0 + \bar{K}^0$ production, the K^0-meson carried off practically all the available energy, whereas a soft hyperon spectrum was observed in $Y^0 + K^0$ production. The cross-sections for the rea tions $\pi^- + \pi^+ \rightarrow K^0 + \bar{K}^0$ $(\sigma \sim 2$ mbn) and $\pi^- + K^{0,+} \rightarrow \pi^{-,0} + K^0$ $(\sigma > \sim 10$ mbn) were found, for ≤ 0.5 BeV final particle kinetic ener in the c.m.s., by assuming that in the reactions under considera tion, at any rate for small transferred momenta, pole diagrams yield a large contribution. [English translation in: Soviet Phys JETP (USA)].

19271 EXAMPLE OF THE DECAY $\Lambda^0 \rightarrow p + \mu^- + \bar{\nu}$.

F.Eisler, J.M.Gaillard, J.Keren, M.Schwartz and S.Wolf.

Phys. Rev. Letters (USA), Vol. 7, No. 4, 136-7 (Aug. 15, 1961).

Reports a clear case of this mode of decay, found in an exposure taken in the 20 in. BNL hydrogen bubble chamber. The theoretical rate for this decay is 2.4×10^{-3}. The event is one of a sample of 3000 Λ^0's presently being analysed. The study is complete and an upper limit on the rate of decay cannot as yet b given.

S.Ch

19272 THE CONTRIBUTION OF INDIRECT PROCESSES T Λ_{e3}-DECAY.

D.Flamm.

Acta phys. Austriaca, Vol. 14, No. 2, 164-74 (1961). In Germa

Matrix elements for the β-decay of the Λ-particle involving the leptonic decay of virtual K-mesons are found to be consider ably smaller than those for the direct decay $\Lambda \rightarrow p + e + \bar{\nu}$, assu that the universal Fermi interaction applies to this process. Th fore, these indirect processes cannot possibly account for the fa of 10 between the observed decay rate and the prediction of univ Fermi interaction.

P.K.K

19273 ASYMMETRY IN THE DECAY OF Λ^0-HYPERONS GENERATED BY 2.8 BeV/c NEGATIVE PIONS, DETERMINED BY OBSERVATIONS IN A FREON BUBBLE CHAMBER.

V.V.Barmin, Yu.S.Krestnikov, I.I.Pershin, V.P.Rumyantseva, Ya.Ya.Shalamov and V.A.Shebanov.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1229-31 (Nov., 1960). In Russian.

The asymmetry was investigated for Λ^0-particles created c on, chlorine, and fluorine nuclei. The measured value of the metry coefficient is $\alpha\bar{P} = -0.30 \pm 0.15$. [English translation Soviet Physics—JETP (USA), Vol. 12, No. 5, 857-8 (May, 1961)].

9274 LEPTON DECAY OF THE Λ-HYPERON AND THE PROBABILITY FOR K_{μ_2} AND K_{e_3} PROCESSES.

.Gandel'man.

eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1672-5 (June, 1961). ussian.

A new postulate is introduced which refers to the divergence of vector part of the baryon current with nonconservation of ngeness. The postulate of Gell—Mann and Levy regarding the rgence of the axial part of the baryon current (Abstr. 15386 of)) is accepted with the modification that the π-meson operator eplaced by the K-meson operator. After this, it is found to be sible to determine the relation between the lepton decay proba- y of the Λ-hyperon and the probabilities for K_{μ_2} and K_{e_3} cesses. The theory yields the result that the vector variant ery important in the lepton decay of the Λ-hyperon. [English slation in: Soviet Physics—JETP (USA)].

19275 COULOMB EXCITATION OF Λ-PARTICLES.

B.N.Valuev.

eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1844-6 (June, 1961). ussian.

The electromagnetic transition $\Lambda \to \Sigma^0$ is examined. This tran- on is of interest in investigating the possibilities of the experi- tal determination of the lifetime of the Σ^0-particle and the ification of isotopic invariance for strange particles (the $He_2^4 \to \Sigma^0 + H_2^4$ and $\Lambda + d \to \Sigma^0 + d$ reactions). [English slation in: Soviet Physics—JETP (USA)].

yperons

9276 THE MASS OF THE Λ^0-HYPERON.

B.Bhowmik, D.P.Goyal and N.K.Yamdagni.

vo Cimento (Italy), Vol. 22, No. 2, 296-303 (Oct. 16, 1961).

An accurate determination of the Λ^0-mass was made using lear emulsion. From an analysis of 101 Λ^0-decays, the value ined for the mass of the Λ^0-hyperon was $M_\Lambda = (1115.46 \pm 0.15)$ MeV $Q_\Lambda = (37.62 \pm 0.14)$ MeV.

9277 ASYMMETRY PARAMETERS IN THE DECAYS $\Sigma^+ \to p + \pi^0$ AND $\Lambda^0 \to p + \pi^-$.

.Beall, B.Cork, D.Keefe, P.G.Murphy and W.A.Wenzel.

s. Rev. Letters (USA), Vol. 7. No. 7, 285-8 (Oct. 1, 1961).

The asymmetry parameters α_0 and α_Λ for the decays $\Sigma^+ \to p + \pi^0$ $\Lambda^0 \to p + \pi^-$ were measured using counters and spark chambers. Σ-hyperons were produced in a hydrogen target by the reaction $+ p \to \Sigma^+ + K^+$, and the Λ-hyperons in lithium deuteride by the ction $\pi^+ + n \to \Lambda^0 + K^+$. The events were identified by detecting K^+-mesons with a counter telescope and registering their decay large water Cherenkov counter. Decay protons were detected scintillation counters and their polarization measured by scatter- in a carbon plate spark chamber, thus allowing the signs of the mmetry parameters to be established. Out of 25 000 pictures, events satisfied the acceptance criteria applied. A maximum lihood method was used to obtain the result $\alpha_0 = +0.75 \pm 0.17$. was found to be negative with a confidence of at least 25 : 1 for $| > 0.6$. Thus $\alpha_\Lambda \cong -\alpha_0$ which agrees with the results of recent eriments in bubble chambers. It is in contradiction with several ories but agrees with the global (or doublet) symmetry theories provides evidence that $\alpha(\Xi^- \to \Lambda^0 + \pi^-)$ is positive.

J.D.Dowell

19278 ON $\Sigma^+ \to p + e^+ + e^-$ AND $\Sigma^+ \to p + \mu^+ + \mu^-$ DECAYS.

I.V.Lyagin and E.Kh.Ginzburg.

. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 914-18 (Sept., 1961). Russian.

An investigation of the process $\Sigma^+ \to p + e^+ + e^-$ is of interest connection with the search of neutral currents in weak inter- ions. According to the theory of universal charged currents str. 507 of 1958), this decay cannot be induced only by weak eraction but can proceed under the influence of strong and ctromagnetic interaction. The total decay probability and oil proton energy spectrum are computed by taking into account circumstance. An expression is also obtained for the probability of the decay $\Sigma^+ \to p + \mu^+ + \mu^-$ and the ratio of the two decay probabilities is estimated. [English translation in: Soviet Physics—JETP (USA)].

19279 ODD Σ—Λ PARITY AND PION—HYPERON SCATTERING.

R.H.Capps.

Phys. Rev. (USA), Vol. 124, No. 3, 945-6 (Nov. 1, 1961).

The static dispersion relations for the S-wave π—Λ and π—Σ scattering amplitudes are investigated under the assumptions that the dominant forces result from a scalar πΛΣ interaction, and that multiple meson processes may be ignored. If it is required that the π—Λ effective range is small, or alternately, that no subtractions be made in the dispersion relation for the denominator function of the π—Λ amplitude, the πΛΣ coupling constant is determined to be $F^2 \cong 1.6$. However, such a strong interaction leads to an attractive force in the isotopic-spin 2, π + Σ S-state that is more than sufficient to produce a bound state. A brief discussion is given of the meaning of this result, and of a possible related mechanism for the 1380 MeV π—Λ resonance.

19280 ON THE DETERMINATION OF THE RELATIVE PARITY OF Σ^0 AND Λ PARTICLES FROM THE REACTION $\Sigma^0 \to \Lambda + e^+ + e^-$.

B.N.Valuev and B.V.Geshkenbein.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1046-8 (Oct., 1960). In Russian.

The problem considered is that of the correlation of the polarizations of the Σ^0 and Λ particles and the electron—positron pair in the reaction $\Sigma^0 \to \Lambda + e^+ + e^-$, in its dependence on the relative parity of Σ^0 and Λ. The correlations are very different for positive and negative relative parity. When there is a polarization of the Σ^0-particles arising in their production, the measurement of the correlation in question can be comparatively convenient method for determining the relative parity of Σ^0 and Λ. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 728-9 (April, 1961)].

19281 1.15 GeV/c STUDY OF THE ASSOCIATED PRODUCTION $\pi^+ + p \to \Sigma^+ + K^+$.

A.Berthelot, A.Daudin, O.Goussu, F.Grard, M.A.Jabiol, F.Lévy, C.Lewin, A.Rogozinski, J.Laberrigue-Frolow, C.Ouannés and L.Vigneron.

Nuovo Cimento (Italy), Vol. 21, No. 5, 693-709 (Sept. 1, 1961). In French.

78 associated production events $\pi^+ + p \to \Sigma^+ + K^+$ were investigated with a propane bubble chamber (40 cm × 20 cm × 20 cm) placed in a 12.7 kG magnetic field. The beam used had a momentum (1.155 ± 0.025) GeV/c, and the composition: $\pi^+:p:\mu^+:e^+ = 100:10:8:1$. The following results were obtained: (1) The total [$\sigma = (0.214 \pm 0.035)$ mb] and differential cross-sections obtained are in agreement with the charge independence hypothesis; (2) for $\Sigma^+ \to \pi^+ + n$ events, no significant asymmetries, up—down, right—left or forward—backward, were found; (3) the mean life of Σ^+ is $\tau = (0.75^{+0.13}_{-0.09}) \times 10^{-10}$ sec.

19282 PRODUCTION OF CHARGED HYPERONS BY 9 BeV PROTONS INTERACTING WITH PHOTOGRAPHIC EMULSION NUCLEI.

L.P.Dzhanelidze, D.K.Kopylova, Yu.B.Korolevich, N.I.Kostanashvili, K.V.Mandritskaya, N.I.Petukhova, M.I.Podgoretskii, D.Tuvdendorzh, O.A.Shakhulashvili and Chzhen Pu-in [Cheng P'u-ying].

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1237-41 (Nov., 1960). In Russian.

The angular distribution of $\pi^\pm$-mesons from decaying $\Sigma^\pm$-hyperons, produced by interaction of 9 BeV protons with emulsion nuclei, was investigated. An estimate is obtained of the charge composition of the hyperons. The cross-section for the production of charged hyperons on emulsion nuclei is estimated. [English translation: Soviet Physics—JETP (USA), Vol. 12, No. 5, 863-5 (May, 1961)].

19283 POSSIBLE BOUND Σ—Λ SYSTEM.

Y.Nambu and J.E.Shrauner.

Nuovo Cimento (Italy), Vol. 21, No. 5, 864-6 (Sept. 1, 1961).

Experimental evidence favours an assignment of odd relative Σ—Λ parity so that the Σ can be considered as a bound system of Λ and π in an s state, with the scalar ΣΛπ coupling constant being of the order of 1. On the basis of such a picture the authors have considered the interaction of a Σ and a Λ through the exchange of a pion. This leads to the view that there is a strong tendency for a bound state formation, and its implications are discussed in some detail.

B.Brown

19284 PRODUCTION OF Ξ^- HYPERONS BY 7 AND 8 BeV/c π^- MESONS. Van Gan-chan [Wang Kang-ch'ang], Van Tsu-tszen [Wang Ts'u-tseng], N.M.Viryasov, Din Da-tsao [Ting Ta-ts'ao], Kim Khi in, E.N.Kladnitskaya, A.A.Kuznetsov, A.Mikhul, Nguyen Dinh Tu, A.V.Nikitin and M.I.Solov'ev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 734-40 (March, 1961). In Russian.

The production and decay of Ξ^- hyperons produced in the interaction between π^- mesons in propane at momenta of 6.8 ± 0.6 and ~ 8 BeV/c were studied. A total of 11Ξ^- hyperons were observed. Their decay energy Q, lifetime τ_0, and production cross-section are given. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 512-17 (Sept., 1961)].

Deuterons

19285 INELASTIC ELECTRON SCATTERING FROM THE DEUTERON. G.A.Peterson and W.C.Barber.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C8/28, p. 831-2.

The magnetic dipole disintegration of the deuteron was studied by the inelastic scattering of 41.4 MeV electrons from C, CD_2, and CH_2 targets at 132°, 160°, and 180°. The measurements at 180° were made by using a new technique which minimizes the background radiative tail arising from elastic scattering. The magnitude of the deuteron inelastic cross-section was obtained by finding the ratio of the inelastic scattering from the deuteron to the elastic scattering from the proton. Near threshold the results are in agreement with the theory of Jankus, but at high excitation energies a discrepancy is observed.

19286 A STUDY OF THE BREAK-UP OF DEUTERONS BY 14.1 MeV NEUTRONS. C.Bonnel and P.Levy.
C.R. Acad. Sci. (France), Vol. 253, No. 4, 635-7 (July 24, 1961). In French.

The effective differential cross-section was determined at two angles by a method which eliminates the yield of elastically-scattered deuterons more accurately. The results are compared with previous experimental and theoretical values. V.M.Rout

19287 EXPERIMENTAL VERIFICATION OF THE CHARGE INVARIANCE PRINCIPLE IN THE $d + d \rightarrow He^4 + \pi^0$. REACTION FOR 400 MeV DEUTERONS.
Yu.K.Akimov, O.V.Savchenko and L.M.Soroko.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9) 708-24 (Sept., 1961). In Russian.

Some experiments with a 400 MeV deuteron beam are described in which the $d + d \rightarrow He^4 + \pi^0$ reaction forbidden by the law of conservation of total isotopic spin was investigated. With a reliability of 90% the total cross-section of the reaction is shown to be smaller than 1.1×10^{-32} cm^2. The upper limit of the cross-section is compared with the cross-section for $d + d \rightarrow He^4 + \gamma$ and also for the reaction $p + He^3 \Rightarrow He^4 + \pi^+$ which is allowed by the isotopic spin selection rules. The data obtained in the present study together with theoretical estimations point to the existence of a strong forbiddeness in the $d + d \rightarrow He^4 + \pi^0$ reaction and hence confirm the validity of the law of conservation of total isotopic spin in processes of π-meson formation by nucleons and light nuclei. [English translation in: Soviet Physics—JETP (USA)].

19288 EFFECTS OF PARITY NON-CONSERVING INTER-NUCLEON POTENTIALS ON THE PHOTOEFFECT IN H^2 AND H^3. R.J.Blin-Stoyle and H.Feshbach.
Nuclear Phys. (Internat.), Vol. 27, No. 3, 395-404 (Oct., 1961).

Several effects of non-parity conserving potentials on the photodisintegration of the deuteron, on radiative neutron capture by hydrogen and deuterium are estimated employing the non-parity conserving potential derived by Blin-Stoyle (Abstr. 17461 of 1960). Observation of the correlation of the circular polarization with the direction of emission of the gamma rays emitted in radiative neutron capture by deuterium appears to be the most promising experiment.

19289 THE ELASTIC SCATTERING OF γ-RAYS BY DEUTERONS BELOW THE PION-PRODUCTION THRESHOLD.
L.I.Lapidus and Chzhou Guan-Chzhao [Chou Kuang-Chao].
Zh. eksper. teor. Fiz. (USSR), Vol. 39. No. 5(11), 1286-95 (Nov., 1960). In Russian.

Dispersion relations and the conditions for unitarity of the S-matrix are used for an analysis of the scattering. The low-energy limit is examined for the scattering of γ-rays by nuclei arbitrary spin. The energy dependence of elastic γd scattering deduced on the basis of the experimental data on the photodisintegration of the deuteron. The result differs decidely from that of the impulse approximation over a wide range of energies. It is foun that it is not important to include the influence of photoproductio pions from deuterons in the range of energy considered. [Englis translation in: Soviet Physics—JETP (USA), Vol. 72, No. 5, 898-903 (May, 1961)].

19290 POLARIZATION OF DEUTERONS ELASTICALLY SCATTERED ON HELIUM. L.S.Dul'kova.
Zh. eksper. teor. Fiz. (USA), Vol. 39, No. 4(10), 1008-10 (Oct., 1960). In Russian.

Results are given of a numerical computation of the compon of the polarization tensor for deuterons from elastic scattering o helium. The calculations were made for angles of 40, 50, 60, 70, and 90°, in the c.m.s., over the energy range 1-3 MeV. The comptations were based on the phase-shift analysis of available experimental data. [English translation in: Soviet Physics—JETP (US Vol. 12, No. 4, 701-2 (April, 1961)].

Tritons

19291 NEUTRON POLARIZATION IN THE T (d, n) He^4 REACTION.
I.S.Trostin, V.A.Smotryaev and I.I.Levintov.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9) 725-7 (Sept., 1961 In Russian.

The azimuthal asymmetry of neutrons from the T (d, n) He^4 reaction ($E = 9.9 \pm 0.7$ MeV) scattered on He^4 nuclei was measure for various angles θ_n of neutron emission. A possible asymmetr was detected for $\theta_n = 70^0$ (laboratory system). The azimuthal asymmetry was measured as a function of the scattering angle on He^4 at this emission angle. The results are compared with the n—He^4 (Seagrave) and p—He^4 (Gammel—Teller) scattering phase shifts. The polarization of the investigated neutrons estimated on basis of the Gammel—Teller phase shifts is $P_T(70^0) = (+32.1 \pm 3.0)\%$, the positive direction being that along the norm $[k_n k_d]$. [English translation in: Soviet Physics—JETP (USA)].

19292 ALPHA-PARTICLE SPECTRA AND THE DIFFERENT CROSS-SECTIONS OF THE REACTION H^3(t, 2n) He^4 AT AN ANGLE OF 90°.
A.M.Govorov, Li Ga En, G.M.Osetinskii, V.I.Salatskii and I.V.Sizo
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 703-7 (Sept., 196 In Russian.

The spectrum of α-particles from the H^3(t, 2n)He^4 reaction was measured in the laboratory coordinates at an angle of 90° for primary tritium nuclei energies between 230 and 1000 keV. The differential cross-section of the reaction was calculated on basis of the spectra thus obtained and found to grow monotonically with increase of the energy from 3 to 5.2 mb $sterad^{-1}$. An appreciable contribution from a two-step process involving the formation of a He^5 nucleus and neutron and subsequent decay of H^5 into an α-par and neutron was observed at all energies of the bombarding partic [English translation in: Soviet Physics—JETP (USA)].

19293 NEUTRONS FROM THE REACTIONS BETWEEN TRITIUM AND HELIUM-3.
J.F.Barry, R.Batchelor and B.E.F.Macefield.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 166 of 1961), Paper C5/28, p. 543-4.

The spectrum of neutrons emitted in the reactions between He^3 and tritium, at 3.23 MeV incident energy, was observed with proton recoil telescope. A high energy group from the reaction $T(He^3,n)Li^5$ (Q-value 10.3 MeV) is resolved from the continuum due to $T(He^3,n\,p)He^4$ reactions. The angular distribution of this neutron group is reasonably consistent with $l = 1$ double stripping to the $P_{3/2}$ state of Li^5. The shape of the continuum suggests that the reaction $T(He^3,p)He^5$, with the subsequent break-up of He^5, is not a major contributor to these neutrons.

294 DIFFERENTIAL CROSS SECTIONS FOR THE T(p,n)He^3 REACTION.
Wilson, R.L.Walter and D.B.Fossan.
ear Phys. (Internat.), Vol. 27, No. 3, 421-30 (Oct., 1961).

The zero-degree differential cross-section was measured a recoil-proton counter telescope at about 0.5 MeV intervals 5 to 13.5 MeV. Relative angular distributions of the neutrons the reaction were also obtained at 0.5 MeV intervals from 13 MeV proton energy. Cross-sections were obtained by alization to the zero-degree telescope measurements. The ibutions, when transformed to the centre-of-mass system, strongly peaked in the backward hemisphere. The centre-of- s distributions were fitted with a Legendre series expansion the total reaction cross-section obtained from the coefficients.

pha-particles

9295 MONTE CARLO CALCULATIONS OF THE ALPHA PARTICLE GROUND STATE. M.H.Kalos.
erford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 961), Paper C3/8, p. 405-6.

The Schrödinger equation for the ground state of an N-particle em may be written as a 3N-dimensional integral equation. If the ing energy is assumed known, leaving the strength of the ntial to be determined, if central forces are used, and if there is equirement for anti-symmetrization,then the kernel is positive integrable. The integral equation is readily solved by Monte lo methods. This technique is applied to the alpha-particle with ple phenomenological pair potentials.

9296 ANGULAR AND MOMENTUM DISTRIBUTIONS OF RESIDUAL NUCLEI PRODUCED IN THE INELASTIC TTERING OF FAST PIONS AND PROTONS ON HELIUM.
.Kozodaev, M.M.Kulyukin, R.M.Sulyaev, A.I.Filippov and A.Shcherbakov.
eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 929-35 (Oct., 0). In Russian.

Reports a study of the quasi-free interaction of fast pions or tons with the nucleons of helium nuclei. The shape of the angu- and momentum distributions of the residual nuclei can be lained within the framework of the Serber—Goldberger model taking into account the transfer of additional momentum due to pling. The possibility of determining the momentum distribu- of the nucleons in the helium nucleus from the momentum ctrum of the residual nuclei is discussed. The momentum dis- oution of the nucleons can be satisfactorily described by a ıssian function that decreases to the value 1/e at an energy = (12 ± 2) MeV. [English translation in: Soviet Physics—JETP A), Vol. 12, No. 4, 644-9 (April, 1961)].

19297 EXCITATION OF THE He^4 NUCLEUS BY 150 MeV π^--MESONS. Yu.A.Budagov, P.F.Ermolov, .Kushnirenko and V.I.Moskalev.
eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1615-17 (June, 1961). Russian.

An upper limit of 3.8×10^{-27} cm^2 for the excitation cross- tion in the following reactions was obtained by investigating the eraction between 150 MeV π^--mesons and helium in a diffusion ud chamber:

$$(1)\ \pi^- + He^4 \rightarrow \pi^- + He^3 + n$$

$$(2)\ \pi^- + He^4 \rightarrow \pi^- + T + p$$

e total cross-section and the cross-section for inelastic π^-He eraction and also the cross-sections for reactions (1) and (2) presented. [English translation in: Soviet Physics—JETP A)].

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

19298 THE TRANSITION EFFECT FOR COSMIC RADIATION IN COMBINED ABSORBERS. E.Friedländer.
Rev. de Physique (Roumania), Vol. 5, No. 3-4, 343-53 (1960). In Russian.

Transition curves are given for systems of Geiger counters in coincidence under varying thicknesses of lead, aluminium and polythene. Anomalous absorption effects were observed at a thickness of about 20 cm of lead. Possible mechanisms are suggested to explain the results. N.A.Porter

19299 A LARGE COSMIC-RAY METER AND COSMIC-RAY SHORT PERIOD FLUCTUATIONS.
K.Torizuka and M.Wada.
Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, No. 2, 162-9 (June, 1960).

A large cosmic-ray meter with the accuracy of 0.3% for one minute counting rate was constructed by using the particle density detector of the air shower apparatus at the Institute for Nuclear Study in Tokyo. The observation of cosmic-ray intensity by this apparatus was started in April 1959. One of the main interests of operating such highly sensitive apparatus is to investigate the short period fluctuation of cosmic-ray intensity, the time scale being in the order of a few to tens of min. Results of analysis of data obtained in April and May 1959 are: (1) the amplitude of short period fluctuation varied diurnally with maximum in the daytime, and (2) the above fluctuations varied also from day to day and showed a positive correlation with mean cosmic-ray intensity. (3) Any coherent periodic short time fluctuations were not found. Brief discussions on these results are given.

19300 ON HIGH ENERGY NEUTRINO PHYSICS IN COSMIC RAYS. M.A.Markov and I.M.Zheleznykh.
Nuclear Phys. (Internat.), Vol. 27, No. 3, 385-94 (Oct., 1961).

Discusses the problems of detecting high-energy cosmic neutrinos in underground experiments. Various kindred problems of high-energy neutrino physics are discussed: (1) the magnitude of weak-interaction cut-off momentum, (2) muon and electron neutrinos, and (3) intermediate boson. It is shown that a reasonable counting rate could be obtained with available equipment.

19301 HYDROGEN NUCLEI OF THE PRIMARY COSMIC RADIATION. C.J.Waddington.
Phil. Mag. (GB), Vol. 6, 965-70 (Aug., 1961).

A small stack of nuclear emulsions was used to determine the flux of cosmic-ray protons over Texas. The experimental procedure was similar to that used previously, but due to the more favourable conditions of the exposure the dependence of the value at the top of the atmosphere on the, rather uncertain, corrections for the overlying matter, was greatly reduced, the correction being a factor of 0.902, compared with 0.694 previously. The value found for the flux at the top of the atmosphere on July 12, 1960 was 540 ± 50 protons m^{-2} ster^{-1} sec^{-1}.

19302 THE ENERGY SPECTRUM AND TIME DEPENDENCE OF THE INTENSITY OF SOLAR COSMIC RAY PROTONS.
A.N.Charakhch'yan, V.F.Tulinov and T.N.Charakhch'yan.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 735-46 (Sept., 1961). In Russian.

Presents data obtained in the stratosphere on the energy spectrum and time dependence of the total intensity of cosmic ray protons produced in the sun during chromosphere flares. [English translation in: Soviet Physics—JETP (USA)].

19303 A NEW MODEL FOR THE HIGH ENERGY NUCLEAR INTERACTION. S.Hasegawa.
Progr. theor. Phys. (Japan), Vol. 26, No. 1, 150-2 (July, 1961).

The analysis of jet showers (on the log tan θ plot) shows the existence of groups of secondaries moving in approximately the same direction. The mean number of pions (including estimated π^0's) in a group is 6, and the mean value of the energy of a group (in c.m.s.) is about 2 Mc^2 (M = nucleon mass). It is suggested that the particles comprising a group are produced by the annihilation of a baryon—antibaryon composite which is produced in a high energy nuclear collision. J.L.Redding

19304

COLLECTED RESULTS FROM THE COSMIC RAY STATIONS FOR JULY 1959.

H.Carmichael and J.F.Steljes.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 10-27.

The cosmic-ray events of July 17, 18 and 19 are described and illustrated by reproductions of mechanically-plotted graphs of the records from 38 neutron monitors, and 13 meson telescopes. Rapid fluctuations due to the injection of high-energy solar particles into the terrestrial atmosphere were prominent in the records. These rapid changes are shown to have been simultaneous over the N hemisphere, but confined to a zone ~ 3000 miles in diameter in N America. D.R.Barber

19305

COSMIC RAYS EMITTED BY THE SUN.

A.N.Charahchyan, U.F.Tulinov and T.N.Charahchyan.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 27-8.

High-level atmospheric outbursts (abnormally large cosmic-ray increases) due to primary protons emitted during the solar events of July 1959 gave energy values ~ 100-120 MeV at geomagnetic latitude, 64°. Five of these outbursts were preceded by intense optical flares. The cosmic ray events occurred between 4 and 15 hr later than the flare event, a time-lag inconsistent with the velocity of the primary solar protons. Correlations were found with other geophysical events e.g. geomagnetic storm sudden-commencements and Forbush decrease of cosmic-ray intensity at sea-level. D.R.Barber

19306

COSMIC-RAY INCREASE ON JULY 16-17,1959.

M.Kodoma and T.Nagata.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 28-32.

The main features of cosmic-ray increase were: (1) two components, one consisting of rather high-energy particles, and the second of lower energy particles; (2) a very long transit time (4-14 hr from the solar flare onset); and (3) a very diffuse terrestrial impact zone. D.R.Barber

19307

OBSERVATIONS OF COSMIC RAY NEUTRONS AT THE TIME OF THE JULY 1959 EVENT.

S.A.Korff and R.Haymes.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 33-4.

The New York University cosmic ray neutron monitor at College, Alaska, recorded a set of 3 Forbush-type decreases each following a major solar flare by ~ 30h. The start of the cosmic ray decreases, the sudden commencement of the geomagnetic storm, and the associated ionospheric disturbance all occurred between 18 and 36 hr after each of the 3 intense flares. The Thule—Sonderström ionospheric path (which was within the polar-cap zone) blacked-out much earlier. D.R.Barber

19308

UNUSUAL COSMIC RAY VARIATIONS IN JULY 1959.

Y.L.Blokh, L.I.Dorman and N.S.Kaminer.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 34-43.

Profiles of the cosmic ray intensity changes observed on 11, 15 and 17 July are analysed, and discussed in relation to the geometric and physical parameters of the individual corpuscular streams emitted from the sun. D.R.Barber

19309

ON THE SUPERPOSITION OF COSMIC RAY MODULATION EFFECTS DURING THE JULY 1959 STORMS.

J.G.Roederer, J.R.Manzano and O.R.Santochi.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 44-9.

The 3 overlapping Forbush-type cosmic ray decreases of 11, 15 and 17 July are used to determine whether or not an actual linear superposition of cosmic ray effects actually occurred. The results suggest that each of the July decreases was caused by an independently-acting, though similar modulation mechanism giving linearly superposed effects on the cosmic radiation. D.R.Barber

19310

COSMIC AND SOLAR PARTICLE RADIATION AT BALLOON ALTITUDES DURING THE PERIOD OF ENHANCED SOLAR ACTIVITY IN JULY 1959.

A.Ehmert, H.Erbe, G.Pfotzer, C.D.Anger and R.R.Brown.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988A of 1961) p. 66-72.

Data collected on a series of balloon flights over Berkeley, USA, and Lindau/Göttingen, Germany are presented. Over Berl only Forbush-type decreases of cosmic radiation were noted. O Lindau, solar-accelerated particles penetrated the earth's atmo sphere down to a pressure level of 100 torr. D.R.Ba

19311

A STUDY ON THE STRUCTURE OF THE EXTENSIV AIR SHOWER.

S.Fukui, H.Hasegawa, T.Matano, I.Miura, M.Oda, K.Suga, G.Tanahashi and Y.Tanaka.
Suppl. Prog. theor. Phys. (Japan), No. 16, 1-53 (1960).

Results obtained with an array comprising scintillation cou for timing and density measurements, μ-meson detectors above below ground, Conversi hodoscopes, total absorption Cherenkov detectors and a transition chamber for the detection of nuclear particles. Shower sizes from 10^4-10^7 particles were studied. T age parameter s was found to be 0.6 to 0.8 for distances of 3 to 30 m from the axis, and 1.2 to 1.4 for distances greater than 30 At less than 3m the distribution fluctuated from shower to showe The lateral distribution of energy was found to be in agreement previous experiments, the mean energy per particle falling from 1000 MeV at 1 m from the axis to about 120 MeV at 50 m. The size spectrum of showers showed a discontinuity at sizes of abou 10^6 particles, the integral exponent changing from 1.4 ± 0.1 to 2.0 ± 0.2. Nuclear particles of energies up to 10^{13} eV were observed, and the lateral distribution and fraction of N-particles measured. The ratio of number of μ-mesons to the number of electrons showed marked fluctuations, which apparently decreas for the larger showers. From the zenith angle distribution the absorption length is derived as 102 ± 15 g cm^{-2}, and from the μ-meson fluctuations the nuclear interaction length is found as 90 ± 15 g cm^{-2}, so that fluctuations in the point of shower origin will be important. A model of shower development is presented, which nuclear interactions are assumed highly elastic, and π^0 m rare. N.A.Po

THE JULY 1959 EVENTS AND ASSOCIATED PHENOMENA. See Abstr. 18085

THE GENERATION OF COSMIC RAYS IN FLARES. See Abstr. 18089

COSMIC PARTICLE FORMATION IN ACTIVE SOLAR REGIONS. See Abstr. 18090

ACTIVE SOLAR REGIONS AND THEIR CORPUSCULAR EMISSION. See Abstr. 18093

19312

THE ONSET TIMES OF COSMIC-RAY STORMS.

K.Murakami and S.Kudo.
Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, No. 2, 155-61 (June, 1960).

The onset times of cosmic-ray storms were investigated wi reference to various detectors located at different places over t world. When a sudden decrease occurs within a few hours befor or after sudden commencement of the geomagnetic storm, the lo time and energy dependencies are measurable. The local time dependency shows that the onsets are generally seen earlier on detectors located in the morning zone than in other time zones the storms occur, though this earlier zone is not always fixed bu fluctuates. For the energy dependency, the lower energy particl seem to decrease earlier than the higher energy ones. It is concluded from these dependencies that a diffusion model is the mo probable for the cosmic-ray storm, at least in the initial stage.

19313

CALCULATION OF AVERAGE PARAMETERS OF EXTENSIVE COSMIC-RAY AIR SHOWERS.

S.I.Nikol'skii and A.A.Pomanskii.
Zh. eksper.teor. Fiz. (USSR), Vol. 39, No. 5(11), 1339-46 (Nov., 1960). In Russian.

Results are presented of a calculation of nuclear-cascade showers containing a given number of electrons at the observati level. The distribution of the production levels is determined fo extensive air showers containing 10^4, 10^5, and 10^6 particles at se level and at 3860 m altitude corresponding to Pamir, USSR. Va shower parameters, averaged over different production levels, compared with experimental data (Nuovo Cimento (Italy), Vol. 3, Suppl. No. 4, 635 (1956); Abstr. 4098 of 1958). [English translati in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 934-9 (May, 19

9314 INVESTIGATION OF LARGE-IONIZATION BURSTS PRODUCED BY COSMIC-RAY PARTICLES AT SEA
/EL. S.Yu.Babetski, Z.A.Buya, N.L.Grigorov, E.S.Loskevich,
Massal'ski, A.A.Oles' and V.Ya.Shestoperov.
eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1551-61 (June, 1961).
ussian.
An arrangement consisting of 128 ionization chambers,
sessing a total area of 10 m^2, was employed to study ionization
sts equivalent to the traversal of 1000 or more relativistic
icles through the chambers. The power exponent of the integral
ctrum of bursts recorded by this large-area arrangement is
1.71 ± 0.04. For separate particles, the spectrum exponent is
1.96 ± 0.03. The causes of this discrepancy and the nature of
large ionization bursts are discussed. [English translation in:
iet Physics—JETP (USA)].

9315 ANGULAR DISTRIBUTION FUNCTION FOR PARTICLES IN A SHOWER PRODUCED BY A PRIMARY PARTICLE
A GIVEN ENERGY. V.V.Guzhavin and I.P.Ivanenko.
eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1682-94 (June, 1961).
ussian.
The angular distribution functions for electrons and photons in
scade shower produced by a primary electron or photon of
e energy E_0 are deduced in the A approximation in cascade
ry (Abstr. 9786 of 1961). The angular distribution functions of
shower particles are also derived in the case when the electrons
photons are continuously being produced along the whole shower
by some non-electromagnetic penetrating component. [English
slation in: Soviet Physics—JETP (USA)].

9316 EXCESS NEGATIVE CHARGE OF AN ELECTRON—PHOTON SHOWER AND THE COHERENT RADIO
SSION FROM IT. G.A.Askar'yan.
eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 616-18 (Aug., 1961).
ussian.
An investigation was carried out on the excess of electrons in
lectron—photon shower caused by annihilation of the positrons
ight and the participation of Compton and δ-electrons in the
ver. It is shown that, at the maximum of the shower, the excess
comprise 10% of the total number of shower particles. The
renkov radiation from this excess charge in a dense medium
stimated. The possibility of recording and using this radio
ssion from showers produced by high energy accelerator
icles or cosmic rays in blocks of dense matter is indicated. The
sibility of recording radio waves from penetrating particle
vers in the ground on the moon by apparatus thrown on the lunar
ace and in underground layers on the earth, in which radio
es can propagate, is also noted. [English translation in: Soviet
sics—JETP (USA)].

A RELATION BETWEEN SOLAR RADIO EMISSION AND LOW-
RGY SOLAR COSMIC RAYS. See Abstr. 18168

9317 THE SPECTRUM OF GALACTIC AND SOLAR COSMIC-RAYS. S.I.Sÿrovatskii.
eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1788-93 (June, 1961).
ussian.
A differential energy spectrum of galactic cosmic-rays is
ined in the form of a power law with an exponent $\gamma = 2.5$, by
ming that the source energy is equally divided between the
netic field, turbulence and the cosmic rays. If a constant
ssure is assumed to be maintained when the solar cosmic-rays
e the region of their production, $\gamma = 3.5$ is obtained for non-
tivistic cosmic rays, and $\gamma = 5$ for ultrarelativistic rays.
glish translation in: Soviet Physics—JETP (USA)].

INVESTIGATION OF AZIMUTHAL EFFECTS IN MESON
WERS PRODUCED BY 9 BeV PROTONS. See Abstr. 19194

THE MAGNETIC FIELDS IN INTERPLANETARY SPACE AS
IVED FROM OBSERVATIONS OF THE COSMIC RAY SOLAR
RE EFFECTS. See Abstr. 18017

9318 THE COSMIC-RAY EQUATOR, AS DETERMINED BY THE SECOND SOVIET SATELLITE.
Savenko, P.I.Shavrin, V.E.Nesterov and N.F.Pisarenko.
eksper. teor. Fiz. (USSR), Vol. 41, No. 3, 985-6 (Sept., 1961).
ussian.
The position of the cosmic-ray minimum at 22 equatorial
sits was measured with a counter carried in the satellite, and the position of the cosmic-ray equator is shown on a map. The results are inconsistent with a dipole model of the earth's field; but within the experimental errors, are equally consistent with the Quenby—Webber model (Abstr. 15492 of 1960), or with an octupole model. [English translation in: Soviet Physics—JETP (USA)].

N.A.Porter

19319 CHANGES IN THE DIURNAL HOUR OF MAXIMUM OF THE COSMIC-RAY INTENSITY. J.Katzman.

Canad. J. Phys., Vol. 39, No. 10, 1477-85 (Oct., 1961).

The diurnal hour of maximum of the meson component changed progressively at Ottawa, Canada, from 10 hr 44 min to 14 hr 40 min during the period January 1955 to December 1960 while the nucleon component changed from 12 hr 12 min to 15 hr 16 min for the same period. This evidence favours the 22 yr cycle in the diurnal hour of maximum that was first suggested by Thambyahpillai and Elliot (Abstr. 7774 of 1953), for stations within a geomagnetic latitude belt between 58.1°N. and 48.1°S. The diurnal hour of maximum at Churchill changed from 14 hr 40 min to 15 hr 24 min during the period April 1957 to December 1960 for the meson component and from 15 hr 12 min to 15 hr 52 min for the nucleon component. Although the change was for a later hour the indication of a 22 yr cycle at Churchill is not impressive. At Resolute the diurnal hour of maximum is dominated by the varying magnetic masses in interplanetary space. It is shown that the anisotropy varies both in magnitude and direction depending on the conditions that exist in the solar system.

19320 DIURNAL VARIATION AND FORBUSH DECREASE. D.Cattani, M.Galli and P.Randi.

Nuovo Cimento (Italy), Vol. 21, No. 6, 923-34 (Sept. 16, 1961).

Discusses the depressions often preceding the most important Forbush decreases by less than 24 hr, and certain features of a Forbush decrease such as the rarity of onsets during morning hours, the greater amplitude when they happen during the evening and the small increases that sometimes happen during the main decrease. It is pointed out that the Forbush decrease is always associated with a train of diurnal variations and, conversely, a train of diurnal variations often contains a more or less evident Forbush-type decrease. Through an analysis of the energy dependence of the above predecreases, and of a separation of local variations from world-wide variations in a Forbush decrease, it is shown that the characteristics associated with a decrease are simply due to the superposition of diurnal variations to the world-wide Forbush decrease. The train of diurnal variations, with the Forbush effect removed, has a variable length that apparently does not exceed about 10 days; it is reinforced and is anticipated in phase during a period of two or three days containing the onset of the Forbush storm.

19321 INTENSITY OF THE COSMIC RADIATION AT GREAT DEPTHS UNDERGROUND. J.C.Barton.

Phil. Mag. (GB), Vol. 6, 1271-83 (Oct., 1961).

The cosmic-ray intensity was measured in a mine using a combined scintillation counter and Geiger counter telescope. It was shown that this apparatus could discriminate effectively against local γ-radiation. The intensities at 1660 m.w.e. and 3280 m.w.e. were 3×10^{-5} and 10^{-6} of that at the surface; no cosmic-ray events were observed at 5050 m.w.e. The results suggest a steepening of the energy spectrum in the region of 10^{12} eV. The most probable energy loss of μ-mesons which had a mean energy of about 3×10^{11} eV was found to be not significantly higher than that of minimum ionizing particles.

19322 ENERGY SPECTRUM AND TOTAL NUMBER OF LOW-ENERGY COSMIC-RAY PHOTONS IN THE STRATOSPHERE. A.N.Charakhch'yan and T.N.Charakhch'yan.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1602-5 (June, 1961).
In Russian.

Results of calculations and experiments on the energy spectrum of cosmic-ray photons in the stratosphere (in the energy range from 50 to 3000 keV) are presented. [English translation in: Soviet Physics—JETP (USA)].

19323 SEA-LEVEL COSMIC RAY SPECTRA AT LARGE ZENITH ANGLES. J.E.Allen and A.J.Apostolakis.

Proc. Roy. Soc. A (GB), Vol. 265, No. 1320, 117-32 (Dec., 1961).

Measurements were made at Durham (200 ft above sea level), with an emulsion spectrograph, of the absolute cosmic-ray particle intensity in the momentum range 1 to 100 GeV/c at zenith angles of between 65° and 85°. It is found that a differential π-meson production spectrum of the form $I_0E^{-\gamma}$ fits closely the present results as well as the accepted vertical spectrum. The values of the parameters when E lies between 6 and 1000 GeV are given by the equations $I_0 = 0{\cdot}425 - 0{\cdot}125 \log_{10} E$ and $\gamma = 3{\cdot}92 - 0{\cdot}944(1 - 0{\cdot}125 \log_{10} E)^{-1}$ and their approximate constant values in this range are 0·15 and 2·55 respectively. The analysis is based on the model of Barrett, Bollinger, Cocconi, Eisenberg and Greisen (Abstr. 1731 of 1953) but, in addition, the effects of scattering and geomagnetic deflection of μ-mesons in the atmosphere were taken into account as well as their production over a range of atmospheric depths. Although in principle it should be possible from the form of the sea-level spectra at large zenith angles to determine the relative numbers of π- and K-mesons at production, it is shown that very great accuracy is required in order to do so. Nevertheless, the agreement between the theoretical curves and the experimental measurements indicates that the main assumptions concerning the production and propagation of mesons in the atmosphere are correct. The mean positive to negative ratio is 1·39 ± 0·08, a value rather larger than is found by other observers at 68°, but within statistical fluctuation.

19324 POLARIZATION OF COSMIC-RAY μ^+-MESONS.
V.V.Barmin, V.P.Kanavets and B.V.Morozov.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4 (10), 986-90 (Oct., 1960). In Russian.

Geiger and scintillation counters were used to measure the degree of polarization of cosmic-ray μ^+-mesons of various energies. The μ^+-meson energy was determined from the mean range in a Cu and Pb absorber placed above the array. The measurements were performed at sea level. The cosmic-ray μ^+-mesons with momentum equal to 0.45, 0.9, and 1.7 BeV/c are 0.23 ± 0.10, 0.37 ± 0.11, and 0.31 ± 0.10, respectively. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 683-6 (April, 1961)].

KNOCK-ON ELECTRONS AND DIRECT ELECTRON PAIR PRODUCTION BY COSMIC-RAY MUONS. See Abstr. 19178

NUCLEUS

19325 COORDINATE [FRACTIONAL] PARENTAGE COEFFICIENTS FOR A CONFIGURATION CONSISTING OF SEVERAL SHELLS.
I.G.Kaplan.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 790-9 (Sept., 1961). In Russian.

Expressions for the coordinate fractional parentage coefficients of an arbitrary multi-shell configuration are derived as products of single shell fractional parentage coefficients and the matrix elements of the transformation matrices of the permutation groups and rotation groups. Formulae for the matrix elements of the operators F and G are presented in the case when they do not contain spin variables. [English translation in: Soviet Physics—JETP (USA)].

19326 PAIRING FORCES AND PAIR CORRELATIONS IN THE NUCLEI Tl^{206} AND Bi^{210}.
L.A.Sliv, G.A.Sogomonova and Yu.I.Kharitonov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 946-53 (March, 1961). In Russian.

The residual pairing forces acting between a neutron and proton in the nucleus are determined. The energies, eigenfunctions and transition probabilities in the nuclei Tl^{206} and Bi^{210} are found and compared with experiment. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 661-6 (Sept., 1961)].

VELOCITY DEPENDENCE OF NUCLEAR POTENTIALS. See Abstr. 19392

19327 SHELL STRUCTURE INVESTIGATION BY ELECTRON SCATTERING ON NUCLEAR PROTONS.
G.Jacob and T.A.J.Maris.

Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C 1/8, p. 153-4.

It is shown that, from angular correlation measurements on energy selected electron—proton pairs resulting from quasi-free scattering, detailed information on the shell structure of light and medium nuclei can be obtained. A calculation for C^{12} is performed, leading to the conclusion that the distortion of the outgoing proton wave merely reduces the magnitude of the cross-section but does not change the shape corresponding to the proton momentum dist bution in the relevant shell. This result is expected also to hold other light and medium nuclei.

19328 THE MOMENTUM DISTRIBUTION IN THE NUCLEUS AND ITS IMPLICATIONS FOR INDEPENDENT PARTICLE THEORIES.

Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16 of 1961), Paper S3/3, p. 386-9.

The experimental and theoretical evidence on the momentum distribution or correlation structure of the nucleus is summarize and its relation to nuclear models is discussed.

19329 THE BOUNDARY CONDITION MODEL OF NUCLEAR FORCES.
E.L.Lomon.

Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16 of 1961), Paper C 1/16, p. 169-70.

The success of the "Boundary Condition Model" as applied to nuclear forces is reviewed. The fact that a boundary condition is a better representation of strong interactions at small distances a static potential is made plausible by three different arguments. The first is that the high energy of virtual states masks the inco energy. The second connects the BCM with maximum non-locali consistent with causality. The third concerns the analytic prope of the BCM amplitude and leads to a quantitative programme.

19330 THE NUCLEAR MANY BODY PROBLEM IN THE BOUNDARY CONDITION MODEL.
E.L.Lomon.

Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16 of 1961), Paper C3/12, p. 413-14.

The "boundary condition model" is applied to the nuclear ma body problem. The successful application of the b.c.m. to the nuclear two-body problem raises the question of its predictions nuclear binding energy, etc. A pseudo-potential is used to repla the boundary condition exactly after which Brueckner equations c be applied, modified for "hole-hole" interactions. The simple solution of the short-range interaction allows for a reasonable numerical programme. The simplicity of the short-range contri bution is further utilized to examine the size of various "correct terms.

19331 THE MANY BODY PROBLEM OF OXYGEN-16.
H.S.Köhler.

Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16 of 1961), Paper C3/13, p. 415-16.

The nuclear many-body problem of O^{16} is investigated by the reaction matrix theory. The single particle wave-functions are taken to be those of a harmonic oscillator. The reaction matrix calculated by the separation method. The two-nucleon interactio represented by a spin-independent potential of potential shape an with a hard core. Only the first-order term and the dispersion correction are calculated. A minimum in total energy of −2 Me (exp[−8 MeV/A]) is obtained at a root mean square radius of 2.74 fermis (exp 2.57 fermis).

19332 NUCLEAR MODEL CALCULATIONS ON Tl^{205}.
L.Silverberg.

Ark. Fys. (Sweden), Vol. 20, Paper 21, 355-81 (1961).

A shell-model calculation is performed with the nucleus co sidered as three holes moving in a static potential and interactin with each other by some residual force. The central two-body fo is treated for conventional values of the entering parameters. T influence of a hard core and a tensor force, treated by means of extremely simplified model, is discussed. Further, the same nu is calculated as a single proton hole coupled to a vibrating core. Various nuclear properties are calculated (B-values for γ-tran- sitions, magnetic moments), and the results of the two calculatio are compared with each other and with the experimental data.

19333 PAIRINGS IN THE SHELL MODEL. III.
M.Umezawa.

Nuclear Phys. (Internat.), Vol. 27, No. 2, 248-69 (Oct., 1961).

For Pt II see Abstr. 13602 of 1961. Pairing energies are obtained for a system of both kinds of nucleons forming a spherical nucleus. Methods for obtaining the general express for the Racah fractional parentage coefficients are developed. To do this each Racah fractional parentage coefficient is decomposed into a multiple of a few coefficients. Each of these coefficients is expressed in a form independent of its ific representation, so that the results can be applied to any of —j, L—S or intermediate pairing schemes. By using these lts, the competition between the spin—orbit force and the ing forces is dealt with for the following cases: (a) the spin— t force is far stronger than the pairing forces (near the j—j t), (b) the singlet pairing force is far stronger than the spin— t force and the triplet pairing force is weak (near the L—S limit). Bogolyubov method for carrying out the whole procedure ribed above is sketched, and the results are compared with e obtained by the Racah method.

9334 COLLECTIVE MOTION IN GIANT PHOTONUCLEAR RESONANCE. I. RESONANCE ENERGY OF SPHERICAL LEI AND SPLITTING OF DEFORMED NUCLEI.

abre de la Ripelle.

ear Phys. (Internat.), Vol. 27, No. 4, 561-80 (Nov., 1961). rench.

In the framework of a quantal treatment of the collective model ogous to the Fujita model, the resonance energy of the ective motion and the splitting for deformed nuclei are ined. It is pointed out that the resonance energy depends on uclear density but very weakly on the potential shape, the ly significant parameters being the r.m.s. radius and the ier transforms of the n—p potentials for very small momentum sfers. For the comparison with experiment the Gammal—Thaler ange potential with hard core is used with a Fermi distribution e nuclear states and the nuclear density parameters of tadter.

TALMI TRANSFORMATIONS IN NUCLEAR SHELL MODEL. Abstr. 19138

OPTICAL MODEL WAVE FUNCTIONS FOR STRONGLY ORBING NUCLEI. See Abstr. 19422

9335 CORRELATION OF COLLECTIVE MOTION WITH MOTION OF "EXTRA" NUCLEONS [IN NUCLEI].

Lubchenko.

ayin. fiz. Zh. (USSR), Vol. 5, No. 2, 274-5 (1960). In Ukrainian.

9336 ON THE CHANGE OF THE SINGLE-PARTICLE ENERGIES DUE TO A VARIATION OF THE PAIR RIBUTION IN NUCLEI OF TYPE SINGLE CLOSED SHELL ± 1.

verberg.

Fys. (Sweden), Vol. 20, Paper 20, 341-53 (1961).

A calculation is performed for nuclei in which one of the nucleon bers differs by only one unit from the magic number 50 or 82. core is described by a pairing and P^2 Hamiltonian, and the ron—proton force is treated as a P^2 + short-range force. The art is treated as vibrations, the short-range part in first-order urbation theory. The energy shifts between different levels in ous nuclei are calculated and compared with experimental data.

9337 ON THE EXISTENCE OF LIGHT NUCLEI WITH LARGE PROTON OR NEUTRON EXCESS. A.I.Baz.

nnaya Energiya (USSR), Vol. 6, 571 (1959). In Russian. ish translation in: Reactor Sci. (GB), Vol. 13, No. 1-2, 74-6 , 1960).

The energy of light nuclei with large neutron or proton excess stimated. The usual relation used to determine Coulomb gies in nuclei is used in reverse and from the known energy ne nucleus the energy of an isobar in the same state estimated. suggested that below A = 40 there must be many undetected tive nuclei which are stable with respect to nucleon emission. mates of half-lives of these nuclei are given. L.L.Green

9338 INTERACTION WITH THE SURFACE IN NUCLEI CONTAINING A NUCLEON IN EXCESS OF A CLOSED LL.

V.N.Guman.

eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 800-5 (Sept., 1961). ussian.

Nuclei with doubly filled shells plus or minus a nucleon are stigated. Single-particle nucleon energies due only to the ral part of the self-consistent potential are singled out by taking account the interaction with nuclear surface vibrations. Surface raction parameters are derived which explain the experimentally blished quadrupole moments and the E2 transition probabilities. applicability of the perturbation method to light nuclei is ussed. [English translation in: Soviet Physics—JETP (USA)].

19339 HARD-CORE EFFECTS ON THE ENERGY GAP IN NUCLEAR MATTER.

G.Fano, M.Savoia and A.Tomasini.

Nuovo Cimento (Italy), Vol. 21, No. 5, 854-8 (Sept. 1, 1961).

See Abstr. 5689 of 1961. It is shown that the energy gap Δ in the spectrum of free quasi-particles in nuclear matter depends strongly on the relativistic details of the interaction.

19340 NUCLEAR MATTER AT LOW DENSITY WITH ATTRACTIVE AND SINGULAR INTERACTIONS.

Y.Wada.

Progr. theor. Phys. (Japan), Vol. 26, No. 3, 321-36 (Sept., 1961).

The theory of nuclear superfluidity is presented by making use of the independent-pair-approximation developed in the Brueckner theory (Abstr. 2515 of 1958). The relation between both theories is clarified in the course of the derivation. A stable configuration of the system is determined by the correlation function between the pairs which satisfies the Cooper—Mills—Sessler (CMS) equation (Abstr. 12187 of 1959). This equation is simplified in such a way that the correct energy gap can be obtained even after the simplification. The variational principle used by CMS is found to give a lower bound to the energy gap. The simplified equation is solved in the low-density limit without making any particular assumption about the two-body potential. When the attraction is so weak as to give a negative scattering length, a diffused Fermi distribution becomes stable. The exact energy gap in this limit is shown to be smaller by the factor $\exp(-2)$ than that of Emery and Sessler (Abstr. 13101 of 1960). If the attraction is strong enough to create a bound state the Fermi distribution is completely diffused. The energy gap is twice the binding energy. Finally, the insufficiency of the independent-pair-approximation is indicated.

19341 THE g-FACTORS FOR COLLECTIVE AND INTERNAL MOTION IN Tb^{159} AND Yb^{173} NUCLEI.

É.E.Berlovich, M.P.Bonits and M.K.Nikitin.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 749-51 (March, 1961). In Russian.

The transition probabilities for magnetic dipole transitions from the first excited states in Tb^{159} and Yb^{173} nuclei were measured with a multi-channel time analyser. The gyromagnetic ratios calculated on the basis of the unified model are compared with results of experiments on Coulomb excitation. The experimental results show that the g-factors for collective motion are close to those estimated on the basis of the unified model according to the formula $g_R \cong Z/A$. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 525-6 (Sept., 1961)].

THE TRANSFORMATION PERMUTATION GROUP MATRIX AND CONSTRUCTION OF THE COORDINATE WAVE FUNCTION OF A MULTISHELL CONFIGURATION. See Abstr. 18275

MONTE CARLO CALCULATIONS OF THE GROUND STATE OF AN N-PARTICLE SYSTEM. See Abstr. 19295

19342 DETERMINATION OF THE NUCLEAR MAGNETIC MOMENT OF Hg^{199} FROM THE HYPERFINE STRUCTURE OF THE Hg I 5461 A LINE.

I.I.Agarbichanu, L.Blanaru, V.Draganesku, N.I.Ionesko-Pallas, N.Komanichu and V.Tatu.

Optika i Spektrosk. (USSR), Vol. 10, No. 3, 297-300 (March, 1961). In Russian.

The hyperfine structure of the 5461 A line of natural mercury was completely resolved using a Fabry—Perot etalon and cooled light sources of different types. The nuclear magnetic moment of Hg^{199} was determined from the experimental data by using theoretical formulae with certain corrections. The value obtained ($\mu_{199} = 0.51\mu_N$) is in good agreement with the value $\mu_{199} = 0.504\mu_N$ obtained from magnetic resonance experiments. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 3, 151-2 (March, 1961)].

19343 DETERMINATION OF THE NUCLEAR MAGNETIC MOMENT OF Na^{23} FROM THE HYPERFINE STRUCTURE OF THE ABSORPTION LINES D_1 AND D_2. V.Draganesku.

Optika i Spektrosk. (USSR), Vol. 10, No. 3, 301-7 (March, 1961). In Russian.

The h.f.s. of the D_1 and D_2 absorption lines of sodium was measured using an atomic beam and was found to be $\Delta\nu(D_1) = 0.058$ cm^{-1}. With the aid of the current, more accurate theory, the magnetic moment of Na^{23} was determined and the value $\mu = 1.97 \pm 0.02$ n.m. (nuclear magnetons) was obtained. Taking into account the polarization of the electron shells of the atom by the optical electron, a more accurate value of $\mu = 2.32 \pm 0.02$ n.m. was obtained for the magnetic moment. Within the limits of experimental error, this corresponds to the value $\mu = 2.217$ n.m. measured by the magnetic resonance method. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 3, 152-5 (March, 1961)].

19344 THE COLLECTIVE GYROMAGNETIC RATIO FOR ODD ATOMIC NUCLEI.
Yu.T.Grin' and I.M.Pavlichenkov.
Zh. eksper. Teor. Fiz. (USSR), Vol. 41, No. 3(9), 954-8 (Sept., 1961). In Russian.

A general expression for the gyromagnetic ratio of even—odd deformed nuclei is obtained by taking into account pair correlation effects. It is demonstrated that the gyromagnetic ratio of odd proton nuclei is greater, and that of odd neutron nuclei smaller, than the ratio of neighbouring even—even nuclei. The results are compared with the experiments. [English translation in: Soviet Physics—JETP (USA)].

19345 QUADRUPOLE MOMENTS OF ODD BARIUM ISOTOPES.
N.I.Kaliteevskii, É.E.Fradkin and M.P.Chaika.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 954-6 (Oct., 1960). In Russian.

The quadrupole moments of Ba^{135} and Ba^{137} nuclei are determined on the basis of the deviations from the spacing rule of the hyperfine structure of the Ba^{137} spectrum. The absolute magnitude of the moments cannot be interpreted in terms of the simple shell model. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 661-2 (April, 1961)].

19346 THE GROUND-STATE EQUILIBRIUM DEFORMATION IN RARE-EARTH NUCLEI. D.R.Bês and Z.Szymański.
Nuclear Phys. (Internat.), Vol. 28, No. 1, 42-62 (Nov., 1961).

The ground-state equilibrium deformation of nuclei was calculated by Mottelson and Nilsson using Nilsson's single-particle model. It is the aim of the present investigation to study the influence of the pairing correlations on this deformation. In addition, the values of the deformation obtained when assuming uniform charge distribution are shown to be in good agreement with the corresponding deformation of the potential. The strength of the quadrupole interaction, needed to account for the empirical electric quadrupole moments, is compared with the values used in other investigations. See also following abstract.

NUCLEAR SPECIFIC HEAT OF HOLMIUM. See Abstr. 17424

19347 EQUILIBRIUM DEFORMATIONS OF NUCLEI IN THE TRANSURANIC REGION. Z.Szymański.
Nuclear Phys. (Internat.), Vol. 28, No. 1, 63-80 (Nov., 1961).

The equilibrium deformations and quadrupole moments of even deformed nuclei in the transuranic region are calculated on the basis of wave-functions that take into account a pairing interaction through the "superconductivity" formalism. The results obtained theoretically are found to be in reasonable agreement with experiment. The relation between the potential and density deformation parameter is also discussed. See also preceding abstract.

19348 AN INVESTIGATION OF THE CONVERSION ELECTRONS FROM THE MÖSSBAUER EFFECT IN TUNGSTEN-182 USING A MAGNETIC SPECTROMETER. E.Kankeleit.
Z. Phys. (Germany), Vol. 164, No. 4, 442-55 (1961). In German.

The recoil-less resonance absorption of γ-rays (the Mössbauer effect) was detected by measuring the conversion electrons associated with the decay of the excited nucleus in a β-spectrometer. The transition investigated was the excitation of W^{182} to its first excited state, 100 keV above the ground, by γ-emission from a metallic source of Ta^{182}. At 22°K it was found that the L-conversion line from the excited W^{182} was 44% above the background. Using the Doppler technique for line breadth, it was found that the half-life of the 100 keV level of W^{182} is $(1.34 \pm 0.13) \times 10^{-9}$ sec. This agrees with other direct methods of measurement but is in disagreement with an earlier measurement based on Mössbauer transmission effects. The temperature dependence of the line strength shows that the Debye temperature for Ta^{182} is $280^{\circ} \pm 10^{\circ}$K. R.O.Davies

MEASUREMENT OF THE REFRACTIVE INDEX OF LUCITE BY RECOILLESS RESONANCE ABSORPTION. See Abstr. 17868

EMISSION AND ABSORPTION OF GAMMA-RAYS (MÖSSBA EFFECT). See Abstr. 17394

19349 BINDING ENERGIES OF LIGHT HYPERFRAGMENT K.Dietrich, R.Folk and H.J.Mang.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16 of 1961), Paper C 1/14, p. 165-6

Binding energies of light hyperfragments are calculated on basis of the independent pair model. The results favour spin ze for ${}_{\Lambda}H^4$ and ${}_{\Lambda}He^4$ and therefore odd K—Λ parity.

SEARCH FOR THE HYPERNUCLEUS (Σ^-n). See Abstr. 19

19350 NON-MESONIC DECAY OF TWO HYPERFRAGMEN G.Baumann, H.Braun and P.Cüer.
C.R. Acad. Sci. (France), Vol. 253, No. 14, 1434-5 (Oct. 2, 1961 In French.

Two new decay modes of the hyperfragments ${}_{\Lambda}Be^8$ and ${}_{\Lambda}B^{11}$ produced by 24.8 GeV/c protons in nuclear emulsion are descri The binding energies calculated are $B_{\Lambda} = 5.1 \pm 5.6$ MeV and $B_{\Lambda} = 4.7 \pm 5.8$ MeV respectively. S.J.St-Lo

Energy Levels

19351 SELECTED TOPICS CONCERNING NUCLEAR SPECTRA. A.Bohr.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 166 of 1961), Paper S8/3, p. 759-62.

Various topics in nuclear spectra, reported in contributions the Conference, are reviewed and discussed.

19352 STABILITY OF AXIALLY ASYMMETRIC NUCLEAR DEFORMATION.
J.Hiura, S.Suekane and H.Tanaka.
Progr. theor. Phys. (Japan), Vol. 26, No. 2, 263-9 (Aug., 1961).

The γ-stability of axially asymmetric nuclear deformation i investigated on the basis of the generalized collective model. I is possible in the vibrational region to make the non-axial defor tion stable for the ground state, but it is necessary in this form ism to introduce a very strong potential to make the axially asy metric shape stable in the rotational region.

19353 FIVE NEW MILLISECOND ISOMERS PRODUCED B 19.2 MeV PROTONS.
A.M.Morozov, V.V.Remaev and P.A.Yampol'skii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4 (10), 973-85 (Oct., 1960). In Russian.

Five new short-lived isomers produced by irradiating Sc_2O Nb, La_2O_3, Nd_2O_3 and Os with 19.2 MeV protons were detected a investigated. The final products of the isomer-yielding nuclear reactions on Sc and La were identified as Ti^{45m} and Ce^{138m}, respectively. By bombardment of In, the previously known isom In^{114m} was produced for the first time through a reaction with protons. More detailed information was obtained about the prop ties of In^{114m}, which has been previously detected in irradiated The excitation function and cross-section for the reaction at 19 MeV were determined for this isomer. The gamma-ray energie half-lives, and relative yields from thick targets were determin for all of the short-lived isomers. [English translation in: Sov Physics—JETP (USA), Vol. 12, No. 4, 674-82 (April, 1961)].

19354 ENERGIES OF ROTATIONAL STATES OF NON-AXI NUCLEI WITH J = 10 AND J = 12. V.K.Luk'yanov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1051-2 (Oct., In Russian.

The energy levels of the lower rotational band in non-axial nuclei are derived for J = 10 and J = 12. A comparison with the experimental data for U^{238} and Th^{232} is made. [English translati in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 731-2 (April, 1

19355 THE POSSIBILITY OF AN EXPERIMENTAL CHEC THE MODEL OF A NON-AXIAL ROTATOR BY STUDYING THE INFLUENCE OF THE MEDIUM ON THE ANGU CORRELATION OF CASCADE GAMMA RAYS. D.P.Grechukin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1371-3 (Nov., 1960). In Russian.

An experiment is proposed for the purpose of checking the
nptions of the model of a non-axial rotator for even—even
i. The experiment is based on measurement of the attenuation
r for angular correlation of γ-quanta for similar cascades in
pes of the same element placed in identical media. [English
lation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 957-8
, 1961)].

356 ON THE NATURE OF THE FIRST EXCITED STATES OF EVEN—EVEN SPHERICAL NUCLEI. S.T.Belyaev.
ksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1387-1400 (Nov.,
). In Russian.
Possible collective excitations are investigated, and their
oscopic structure is analysed. It is shown that the excitations
ound states of the particle—particle or particle—hole types,
nding on the interaction. The quadrupole excitations correspond
e excitations previously found by macroscopic study. The
ficance of the polarizability of the core is investigated.
lish translation in: Soviet Physics—JETP (USA), Vol. 12,
, 968-76 (May, 1961)].

357 THE E2 TRANSITION PROBABILITY FROM THE FIRST 2^+ LEVEL IN SPHERICAL NUCLEI. Yu.T.Grin'.
ksper. teor. Fiz. (USSR), Vol. 40, No. 3, 784-5 (March, 1961).
ssian.
The probability for an E2 transition from the first excited
tate to the ground state as a function of the number of particles
rived on the basis of a microscopic description of the first
ted 2^+ state in spherical nuclei. [English translation in: Soviet
ics—JETP (USA), Vol. 13, No. 3, 550-1 (Sept., 1961)].

358 ROTATIONAL STATES OF ODD NUCLEI WITH SMALL NON-AXIALITY. A.S.Davȳdov and R.A.Sardaryan.
ksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1429-33 (May, 1961).
ssian.
Reports a computation of the dependence of the energy spectrum
e excited states of odd nuclei with a $\frac{5}{2}$ spin in the ground state on
atio of the rotational energy to the coupling energy between the
rnal nucleon and non-spherical part of the core potential.
lish translation in: Soviet Physics—JETP (USA)].

359 THE PROPERTIES OF SOME STRONGLY DEFORMED NUCLEI. Lyu Yuian'[Lu Yang], N.I.Pyatov,
.Solov'ev, I.N.Silin and V.I.Furman.
eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1503-10 (May, 1961).
ussian.
An improved scheme of single-particle levels of a self-
sistent field is employed to investigate some properties of
ngly deformed nuclei in the range $150 < A < 190$ on the basis of
superfluidity model of the nucleus. The mean values of the
coupling constants are evaluated by comparing the calculated
energies with the experimental data. The density of low-
gy single-particle levels of odd nuclei is calculated and found
gree with the experimental data and to exceed the level density
licted by the Nilsson scheme by, approximately, a factor of 2.
e regularities in the behaviour of weakly excited states in
—even nuclei are noted. On the average the errors in the
ulations due to conservation of the number of particles do not
ed 6%. [English translation in: Soviet Physics--JETP (USA)].

9360 THE NATURE OF COLLECTIVE LEVELS IN NONSPHERICAL NUCLEI. D.F.Zaretskii and M.G.Urin.
eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 898-906 (Sept., 1961).
ussian.
A microscopic interpretation of the so-called β- and γ-vibra-
al levels in nonspherical nuclei is presented. By means of an
oximate second quantization method, an equation is derived for
rmining the frequencies of the indicated levels. Electromagnetic
sition probabilities for these levels are computed. The theory
ompared with the experiments. [English translation in: Soviet
sics—JETP (USA)].

9361 LEVEL STRUCTURE OF A^{40}. J.Benveniste, R.Booth and A.C.Mitchell.
lear Phys. (Internat.), Vol. 27, No. 4, 665-72 (Nov., 1961).
The energy spectrum of inelastically scattered protons leading
xcited levels in A^{40} was measured at bombarding energies of
and 9.39 MeV using the Livermore variable-energy cyclotron. The argon target was contained in a 7 cm diameter gas cell with mylar window extending uninterruptedly for about 300° except for the region within 15° of the beam line. The protons were observed in a "particle-namer" detector incorporating a gas proportional counter and p—n junction solid-state detector. Twenty-one levels were observed up to an excitation energy of 6.65 MeV.

19362 POSITIVE PARITY STATES OF Be^9 AND C^{13}. F.C.Barker.
Nuclear Phys. (Internat.), Vol. 28, No. 1, 96-121 (Nov., 1961).

The states produced by weakly coupling a 2s- or 1d-neutron to a core consisting of the ground or first excited state of C^{12} are mixed by means of a two-body control interaction and a one-body spin—orbit interaction of the type normally used in intermediate-coupling calculations, to provide the low-lying positive-parity eigenstates of C^{13}. The positions and neutron widths of the states agree satisfactorily with experimental data, as do the calculated cross-sections for photoneutron disintegration of C^{13}; however, in order to obtain agreement with other data involving E1 radiative widths the single-particle shell-model wave-functions must be modified so as to have the correct asymptotic form. Similar calculations are performed for the Be^9 positive-parity states, about which little is known experimentally.

19363 GAMMA-RAY DECAY OF THE 7.66 MeV LEVEL OF C^{12}. D.E.Alburger.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C8/27, p. 829-30

Two investigations of the 3.23 MeV gamma-ray branch from the 7.66 MeV helium-burning level in C^{12} were carried out. In the first experiment the state was excited by the $B^{10}(He^3,p)C^{12}$ reaction and scintillation detectors were used to measure p,γ,γ triple coincidences, the proton spectrum being displayed. The coincidence effect observed leads to a 3.23 MeV gamma-ray branch of $(3.3 \pm 0.9) \times$ $\times 10^{-4}$ per 7.66 MeV level formed. In the second experiment an upper limit of 5×10^{-4} for this branch was obtained from gamma—gamma coincidence measurements of B^{12} beta activity.

19364 SINGLE PARTICLE EXCITED STATES AND THE MODEL DESCRIPTION OF LIGHT NUCLEI.
V.G.Neudachin and V.N.Orlin.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 874-6 (Sept., 1961). In Russian.

It is demonstrated that the spacing of positive parity levels and their reduced nucleon widths in C^{13}—N^{13} are in good agreement with the unified model. This signifies that the cause of the small distance between the ground level of C^{13}—N^{13} and the closest positive parity single particle level is the large deformation of the nucleus. The general features of giant dipole resonance satisfactorily agree with the concept of strong deformation of light nuclei. It is suggested that the outer nucleon in O^{17} moves in the field of a strongly non-spherical core with tetrahedral symmetry. It is possible that the α-model provides a most general description of collective properties of light nuclei. In some cases (C^{13}—N^{13}, Mg^{25}—Al^{25} etc.) the description of single particle levels within the framework of the α-model may be close to the description provided by the unified model. [English translation in: Soviet Physics—JETP (USA)].

19365 DETERMINATION OF THE LIFETIME OF THE 283 keV EXCITED LEVEL OF Dy^{160}.
J.Burde and M.Rakavy.
Nuclear Phys. (Internat.), Vol. 28, No. 1, 172-6 (Nov., 1961).

The lifetime of the 4+ level at 283 keV of Dy^{160} was measured by the technique of delayed coincidences between the beta-spectrum of Tb^{160} and the appropriate K-conversion line following the de-excitation of this state, using a double-lens coincidence spectrometer. The mean lifetime of the 283 keV was found to be $\tau =$ $= (10.9 \pm 1.1) \times 10^{-11}$ sec. The measured ratio

$$B(E2;\ 4+ \rightarrow 2+)/B(E2;\ 2+ \rightarrow 0+) = 1.65 \pm 0.33$$

agrees fairly well with the value 1.43 predicted by the collective model. An upper limit of $\tau < 2.5 \times 10^{-11}$ sec was also found for the 2^- level of Dy^{160} at 1264 keV using the same method.

19366 DETERMINATION OF THE 3.3 ± 0.2 nsec HALF-LIFE OF THE 103.2 keV LEVEL IN Eu^{153}.
P.Reyes-Suter and T.Suter.
Ark. Fys. (Sweden), Vol. 20, Paper 25, 399-402 (1961).

The half-life was redetermined by delayed electron—electron coincidence technique. Electromagnetic transition probabilities are given.

19367 NUCLEAR RESONANCE FLUORESCENCE MEASUREMENTS ON THE 845 keV LEVEL IN Fe^{56}.

W.H.Kelly and G.B.Beard.
Nuclear Phys. (Internat.), Vol. 27, No. 2, 188-92 (Oct., 1961).

Nuclear resonance fluorescence was observed for the 845 keV level of Fe^{56}. A gaseous source of Mn^{56} as $MnCl_2$ was used in order to utilize the recoil due to previous radiations to compensate for the recoil Doppler broadening of the emission and absorption lines. Resonant self-absorption measurements gave a half-life of $(6 \pm 2) \times 10^{-12}$ sec for the state.

19368 LIFETIME AND g-FACTOR OF THE FIRST EXCITED STATE IN Fe^{56}. F.R.Metzger.

Nuclear Phys. (Internat.), Vol. 27, No. 4, 612-19 (Nov., 1961).

With the gamma-rays from a gaseous source of Co^{56}, resonance scattering from the first excited state of Fe^{56} was observed. From a study of the self-absorption of the resonance radiation, a width $\Gamma = (6.2 \pm 1.0) \times 10^{-5}$ eV was obtained. Making use of the large magnetic field at the position of the iron nuclei, the rotation of the very anisotropic pattern was observed when the iron scatterer was placed in an external field perpendicular to the plane of scattering. The measured precession angle corresponds to a g-factor of $+0.53 \pm 0.16$.

19369 DETERMINATION OF THE 7.0×10^{-9}-SECOND HALF-LIFE OF THE 134 keV EXCITED STATE IN MERCURY 197.

T.Suter, P.Reyes-Suter and T.R.Gerholm.
Ark. Fys. (Sweden), Vol. 20, No. 12, 183-6 (1961).

The half-life of the first excited state in Hg^{197} was measured by delayed electron—electron coincidence technique.

19370 DETERMINATION OF PARITY CHANGE FROM INELASTIC ANGULAR DISTRIBUTIONS.

N.M.Hintz, C.D.Kavaloski, L.L.Lee, Jr. and T.Stovall.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/11, p. 509-10.

Measurements were made of the inelastic angular distributions of 39.7 MeV incident protons from the strongly excited 2^+ and 3^- states of Ni^{58} and Ni^{60} to study the suggestion of Kromminga and McCarthy that the small-angle behaviour of direct inelastic cross-sections would reveal the parity change. Their suggestion is confirmed. The Blair phase rule is also seen to be moderately well obeyed for protons at 40 MeV.

SPIN OF Po^{214} ENERGY LEVELS. See Abstr. 19420

19371 LOW LYING STATES OF Th^{229}.

T.Andersen, K.M.Bisgård and P.G.Hansen.
Nuclear Phys. (Internat.), Vol. 27, No. 4, 673-80 (Nov., 1961).

The decay of 1.6×10^5 yr U^{233} was studied by means of a six-gap beta-ray spectrometer, a xenon-filled proportional counter and scintillation spectrometers. Internal-conversion electrons having energies below 100 keV were measured. The mixing ratios for the 42 keV and the 55 keV transitions agree with the assumed rotational character of the 42 keV and 97 keV states. Results concerning the 163 keV state indicate that this state is also a member of the ground-state rotational band.

19372 ENERGY LEVELS IN THE STABLE ISOTOPES OF TITANIUM. O.Hansen.

Nuclear Phys. (Internat.), Vol. 28, No. 1, 140-7 (Nov., 1961).

The excitation energies of a number of nuclear levels in the stable Ti isotopes were determined from inelastic proton and deuteron scattering and from (d, p) reactions. New levels were found in Ti^{47}, Ti^{49} and Ti^{50}. The (d, p) reaction Q-values and the nuclear level schemes derived from the measurements are compared with older data and are discussed briefly in terms of the quasiparticle model.

19373 THE ENERGY LEVELS OF U^{233}.

R.G.Albridge, J.M.Hollander, C.J.Gallagher and J.H.Hamilton.
Nuclear Phys. (Internat.), Vol. 27, No. 4, 529-53 (Nov., 1961).

The beta-decay of Pa^{233} was studied by means of high-resolution permanent-magnet electron spectrographs, an iron-free double-focusing beta-spectrometer and a curved-crystal gamma-ray spectrometer. Measured values of relative conversion-electron and photon intensities are used to determine conversion coeffici and to assign multipolarities and multipole mixing ratios for the transitions in U^{233}. The quantum assignments of the levels in U^{2} are considered, by comparisons of observed beta and photon branching ratios with those predicted by theory. Several new transitions were observed and some of these are used to postulat new levels in U^{233}.

NEW ENERGY LEVELS OF Xe^{132}. See Abstr. 19395

19374 AN ISOMERIC STATE OF Y^{90}.

C.Carter-Waschek and B.Linder.
Nuclear Phys. (Internat.), Vol. 27, No. 3, 415-17 (Oct., 1961).

An isomeric state of Y^{90} decaying with a half-life of 3.2 ± 0.1 hr was obtained in the bombardment of Rb and Y, respectively, with 12 MeV alphas and deuterons. The observed gamma peaks can be fitted into an energy diagram with levels at 0.202 ± 0.005 and 0.690 ± 0.003 MeV. Consideration of the shell model and existing decay schemes for Y^{90} leads to the assignmen of 7^+ for the isomeric state at 0.690 MeV.

19375 ISOMERIC LEVEL IN Y^{90}.

J.M.Ferguson.
Nuclear Phys. (Internat.), Vol. 27, No. 2, 344-7 (Oct., 1961).

A 3.5 hr activity was produced by fast-neutron bombardment yttrium and zirconium. The evidence indicates this activity is Y^{90m}. Two gamma-rays in cascade were found with energies of 200 keV and 493 keV. It is felt that the isomer consists of a 7+ le at 693 keV decaying to the 3− level in Y^{90} at 200 keV.

NUCLEAR DECAY
RADIOACTIVITY

19376 ANALYSIS OF THE CORRELATION COEFFICIENT THE UNCERTAINTY FUNCTION $X(t) = \pm 1$. APPLICATION TO THE STUDY OF THE DISINTEQUATION LAWS OF RADIOELEMENTS. G.Landaud and C.Mabboux.

J. Phys. Radium (France), Vol. 21, No. 7, 615-16 (July, 1960). In French.

Describes an apparatus which generates the function $X(t) =$ It consists of an assembly of a radioactive source, bistable multivibrator and a detector. It has been used to obtain the stationary Poisson distribution for Co^{60} disintegration.

19377 RADIOACTIVITY IN CERVIDAE ANTLERS.

H.Foreman, M.B.Roberts and E.H.Lilly.
Z. Phys. (Germany), Vol. 164, No. 5, 537-45 (1961).

The experience gained in this study indicated that Cervidae antlers afford a convenient means for measuring levels of ambien radioactivity over large areas. By the use of antlers, it was poss to compare Sr^{90} levels resulting from bomb testing "fallout" year year from 1943 to 1958 in a number of areas in the United States, Canada, and Alaska. The most surprising finding was the very hi levels for Alaska in 1958. From calculations based on total beta counts in antlers, it was possible to show that the radiation dose delivered to bone from short-lived fission products is insignifica as compared to the dose delivered by Sr^{90}/Y^{90}.

19378 THE APPLICATION AND MEASUREMENT OF THE CURRENT FROM URANIUM.

R.Höhle, C.F.Weiss and G.Reichel.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 536-8 (1960). In German.

Reports new measurements of the current emitted by uraniu oxide.
R.H.Tho

19379 ON THE POSSIBILITY OF PROTON DECAY OF NUCLEI. V.A.Karnaukhov and N.I.Tarantin.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1106-11 (Oct., 1961). In Russian.

The possible existence of proton radioactivity is considered. The region of nuclei in which it seems most feasible to search fo n radioactive isotopes is determined. The expected lifetimes active nuclei are estimated and the role of competing pro- s (α and β^+ decay, K capture) is discussed. Possible re- ns leading to the formation of p-active isotopes are indicated heir cross-sections are estimated. [English translation in: t Physics—JETP (USA), Vol. 12, No. 4, 771-4 (April, 1961)].

380 TWO-PROTON RADIOACTIVITY.

V.I.Goldansky.

ar Phys. (Internat.), Vol. 27, No. 4, 648-64 (Nov., 1961).

Basic information is presented on two-proton radioactivity, v and unique kind of nuclear radioactive decay which was cted previously. The paper enumerates the 2p-radioactive i and the optimum conditions of producing them in reactions the participation of He^3 or heavy multicharged ions, with the ation of the number of evaporated neutrons and the thresholds ese reactions. Estimates are made of the cross-sections for roduction of 2p-radioactive nuclei, which reach 0.1 to 1 mb. r consideration are the energy and angular correlations of the mitted protons depending on the nature of their interaction n the nucleus and outside it. The interpretation of the triple on of nuclei with the emission of long-range alpha-particles is ested by analogy with certain properties of two-proton decay.

381 THE HALF-LIFE OF Sm^{153}.

R.E.Green and W.H.Walker.

d. J. Phys., Vol. 39, No. 8, 1216-20 (Aug., 1961).

Reports a measurement of the half-life of Sm^{153}. The value ined (46.2 ± 0.1 hr) is in good agreement with previous rminations. R.H.Thomas

DECAY OF U^{233}. See Abstr. 19371

9382 METHOD FOR DETERMINATION OF THE HALF-LIVES OF SHORT-LIVED GASEOUS RADIOISOTOPES. THE F-LIVES OF THORON (Rn^{220}) AND ACTINON (Rn^{219}).

denbusch and G.Herrmann.

aturforsch. (Germany), Vol. 16a, No. 6, 577-82 (June, 1961). erman.

It is assumed that positively charged and relatively long-lived hter products are formed from the gaseous radioisotopes. The ged decay products are collected on negatively charged mesh trodes and their activity measured. The half-lives are then ined from the streaming velocity of the gaseous isotopes and the activity of the electrodes. The method was applied to on and actinon, the half-lives found being 56.6 ± 0.8 sec. and ± 0.06 sec respectively, in good agreement with the directly sured values. The effects of the electrode potential, the ier gas and its streaming velocity on the collector efficiency e studied. It was found that at high electrode potentials there a definite tendency for the decay products to become focused e centre of the electrode. S.J.St-Lorant

9383 EQUATIONS FOR ALPHA-DISINTEGRATION ENERGIES.

Y.P.Varshni and R.N.Bhargava.

vo Cimento (Italy), Vol. 22, No. 3, 449-56 (Nov. 1, 1961).

For nuclei with $Z \geq 84$ and $N \geq 128$, it is shown that $- 0.625\ Z)$ is a smooth function of the mass number A, where Q e α-disintegration energy. This is utilized to develop two ations for Q. Results by these two equations are compared with e given by Roger's equation (Abstr. 4902 of 1955).

9384 RELATIVE PROBABILITIES OF α-DECAY TO ROTATIONAL LEVELS OF NON-AXIAL EVEN—EVEN LEI.

V.S.Rostovskii.

eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1411-17 (May, 1961). ussian.

The wave-function for a system consisting of a nucleus and an article is derived under the assumption that it is constant on the face of a non-axial nucleus. The relative probabilities for ecay to the levels of the ground and "anomalous" rotational ds of the daughter nucleus are also determined. The results are pared with the experiments. [English translation in: Soviet sics—JETP (USA)].

19385 EFFECT OF ZERO VIBRATIONS OF THE SHAPE OF HEAVY NUCLEI ON THE PROBABILITY OF α-DECAY.

.Nosov.

eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 806-9 (Sept., 1961). In Russian.

The α-decay theory previously developed for nonspherical nuclei is employed for determining a new shape characteristic, the zero vibration amplitude for quadrupole deformation of nonspherical nuclei. It is shown that in various types of experiments, different deformation values are actually being measured. In particular, the difference between the quadrupole deformation determined from α-decay and its equilibrium value can be expressed in terms of the mean square fluctuation deformation in the ground state of the nucleus. The mean square fluctuation deformation in this state is derived from the experimental data for 21 even—even nuclei. The amplitude of quadrupole deformation zero vibrations possesses a sharp maximum at the point of transformation of spherical nuclei into nonspherical nuclei. [English translation in: Soviet Physics—JETP (USA)].

19386 ALPHA ACTIVITIES AND MASS NUMBER ASSIGNMENTS OF LIGHT ASTATINE ISOTOPES PRODUCED BY HEAVY ION REACTIONS.

W.Forsling, T.Alväger, L.W.Holm, O.Melin, J.Uhler and B.Åström.

Ark. Fys. (Sweden), Vol. 19, Paper 7, 83-98 (1961).

For the study of neutron-deficient astatine isotopes, gold was bombarded with carbon and neon ions in the Stockholm 225 cm cyclotron. Chemical isolations and mass separations were made, and the alpha-activities were determined with respect to half-lives and energies using ion chamber techniques. The isotopes At^{202}, At^{203}, At^{204}, At^{205}, At^{206}, and At^{207} were studied.

19387 CONSERVATION OF SPIN AND PARITY IN THE ALPHA DECAY OF O^{16}.

P.F.Donovan, D.E.Alburger and D.H.Wilkinson.

Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C8/26, p. 827-8.

A limit on the width for alpha-decay of the 2 state at 8.88 MeV in O^{16} was determined. Levels in O^{16} were populated by β^- decay of N^{16}, and the energy spectrum of the consequent delayed alpha-particles was examined for evidence of alpha-decay of the 8.88 MeV level. A limit on F^2 of $\sim< 6.6 \times 10^{-13}$ is suggested.

19388 A PHOTOGRAPHIC PLATE STUDY OF THE URANIUM-235 RADIOACTIVITY.

J.Catalá and J.Casanova.

An. Real Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 1-2, 57-9 (Jan.-Feb., 1960). In Spanish.

Ilford L-2 emulsion was charged with 89.5% enriched uranyl nitrate. 886 horizontal tracks were scanned, with an average range of 19.4 μ; U^{238} and U^{235} α-groups can be distinguished, with an average range of 18.3 μ for U^{235}. A few long-range particles were also observed. B.Cimbleris

19389 MEASUREMENT OF LOW-ENERGY BETA-RAY SPECTRA USING A HIGH-PRESSURE PROPORTIONAL COUNTER.

P.E.Shearin and R.L.Hoover.

Phil. Mag. (GB), Vol. 6, 987-95 (Aug., 1961).

In order to eliminate self-absorption in solid and liquid sources in the study of low-energy beta-particle emitters, radioactive gas is introduced in a proportional counter. The cathode of the counter is made of wires and is surrounded by a ring of nine anti-coincidence guard counters. The main-counter anode is unequally divided to minimize end effects. The low-energy spectrum of C^{14} was measured and the experimental data agree with the theoretical plot from 0.5 keV upward to 7 keV within statistical limits.

POSSIBLE BETA-ACTIVE NUCLEI. See Abstr. 19337

19390 BETA DECAY MATRIX ELEMENTS IN As^{76}.

F.M.Pipkin, G.E.Bradley and R.E.Simpson.

Nuclear Phys. (Internat.), Vol. 27, No. 3, 353-84 (Oct., 1961).

Dynamic nuclear orientation was used to study the $2^- \leftrightarrow 2^+$ 2.41 MeV β-ray in the decay of As^{76}. The As^{76} was a substitutional donor atom in a silicon crystal and it was oriented by saturating each of the four $\Delta(m_J + m_I) = 0$ forbidden transitions. The angular distribution of the gamma rays following the 2.41 MeV β-ray was measured with two scintillation counters. The electron and and nuclear relaxation times were determined by observing the rate of growth and decay of the anisotropy of the gamma rays. The electron ($\Delta m_J = \pm 1$, $\Delta m_I = 0$) relaxation time was (3.6 ± 0.7) min. The nuclear relaxation can be attributed to a modulation of the isotropic hyperfine interaction; the relaxation time for the nuclear polarization is (3.1 ± 1) × 10^3min. An analogue computer was used to correct the initial orientation parameters for the effects of nuclear relaxation. From this orientation experiment restrictions can be placed on the angular momentum carried off by the 2.41 MeV β-ray. This result was analysed in conjunction with $\beta-\gamma$ angular correlation and $\beta-\gamma$ circular polarization correlation experiments to determine the beta-decay matrix elements. The set which fits the data best is V = − (0.9 ± 0.2), Y = −(0.9 ± 0.2). It is not impossible to rule out the set V = −(18 ± 5), Y = 0 ± 4.

19391 MEASUREMENT OF THE LONGITUDINAL POLARIZATION OF ELECTRONS EMITTED IN THE β-DECAY OF Au^{198}.

R.O.Avakyan, G.L.Bayatyan, M.E.Vishnevskii and E.V.Pushkin.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 681-3 (Sept., 1961).
In Russian.

The dependence of polarization on β-electron energy was investigated for Au^{198}. The results of measurement of the β-electron polarization for Au^{198} are presented relative to the values for Sm^{153}; the polarization values are given in v/c units. The polarization significantly differs from unity for Au^{198} at β-electron energies of 60, 90 and 190 keV. A spherical condenser was employed to change longitudinal into transverse polarization. The polarization was calculated from the asymmetry of β-electron scattering in a heavy element.

19392 RELATIVISTIC MATRIX ELEMENTS AND THE VELOCITY DEPENDENCE OF NUCLEAR POTENTIALS.

R.W.Hayward and D.D.Hoppes.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C7/5, p. 725-8.

The forbidden beta-decay matrix elements in the transitions of Ce^{141} to the ground and first excited states of Pr^{141} are calculated. The relative values of the momentum dependent matrix elements, when analysed on the basis of an independent particle model, provide information on the nuclear potential. The parameters of a velocity dependent, isotopic spin independent potential with spin—orbit splitting are determined.

19393 DECAY CHAIN $Er^{158}\xrightarrow[E]{2.5\ h}Ho^{158}\xrightarrow[E,\beta^+]{27\ min}Dy^{158}_{stab}$

N.A.Bonch-Osmolovskaya, B.S.Dzelepov, O.E.Kraft and Wang Young-Yu.
Nuclear Phys. (Internat.), Vol. 27, No. 4, 581-5 (Nov., 1961).

The existence of the radioactive chain Er^{158}(2.5 hr) → Ho^{158}(27 min) → Dy^{158}_{stab} is established. A change in intensity of 330 keV and 715 keV positrons was observed. An analysis of the accumulation and disintegration curves at these positron energies and of positron spectra in Er and Ho isolated from Er warrants the conclusion that the β^+-spectrum with $E_{e.p.}$ = 1320 keV belongs to the daughter Ho^{158}, while the β^+-spectrum with $E_{e.p.}$ = 780 keV belongs to the decay of Er^{158} itself.

19394 DECAY OF Er^{172} AND Tm^{172}.

P.G.Hansen, O.J.Jensen and K.Wilsky.
Nuclear Phys. (Internat.), Vol. 27, No. 3, 516-28 (Oct., 1961).

The isotopes Er^{172} and Tm^{172} were produced by double n-capture in Er^{170} and isolated by ion exchange chemistry. The radiations were studied mainly by scintillation methods and coincidence techniques. A tentative decay scheme for Er^{172} is given. The Tm^{172} decay scheme includes levels at 79, 260, 1170, 1467, 1550 and 1609 keV. The main β-groups have the following energies (log ft values are given in parentheses) 1920 keV (8.9), 1840 (8.7), 1660 (10.0) 740 (7.9), 450 (6.8) and 310 (6.5). The β-decay to the ground state rotational band shows that Tm^{172} must have spin and parity 2^-. This assignment is confirmed from a more detailed consideration of the β-transition probabilities. The single-particle configuration for Tm^{172} is discussed.

19395 ON THE DECAY OF I^{132}.

H.G.Devare.
Nuclear Phys. (Internat.), Vol. 28, No. 1, 148-58 (Nov., 1961).

The beta-ray spectrum from the decay of I^{132} was investigated with a magnetic lens and intermediate image type spectrometers. A new beta-group with an end-point energy of 2920 ± 40 keV landing on the first excited state of Xe^{132} was detected. The gamma-ray spectrum was studied with a scintillation spectrometer. The relative intensities of the gamma-rays were estimated. A ground-state transition was detected from a level at 2630 keV which was iden fied as a possible first excited octupole vibrational state. The summing gamma-ray spectrum is investigated with a well-type scintillation crystal. Existence of new levels in Xe^{132} at ≅ 3100 ke ≅ 3400 keV and ≅ 3550 keV is inferred.

19396 RELATIVE MEASUREMENTS ON THE LONGITUDI POLARIZATION OF BETA RAYS FROM Na^{24}, Mn^{56}, Sb^{122}, Ho^{166} AND Au^{198}.

R.Sosnowski, Z.Wilhelmi and J.Wojtkow
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16 of 1961), Paper C7/6, p. 729-30.

The longitudinal polarizations of electrons from β-decay of N Mn^{56}, Sb^{122}, Ho^{166} and Au^{198} were compared. The degree of pola ization was measured by the electron scattering in a thin gold fo Longitudinal polarization was changed into transverse polarizati by means of crossed electric and magnetic fields. The measure ments were carried out for the electrons with v/c = 0.85. The results suggest that the longitudinal polarization is not identical the measured beta-transitions.

BETA-DECAY OF Pa^{233}. See Abstr. 19373

19397 THE BETA-DECAY OF RaE [Bi^{210}].

J. I.Fujita.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16 of 1961), Paper C7/3, p. 723-4.

The spectrum of RaE (Bi^{210}) beta-decay has been previously explained as an accidental cancellation between nuclear matrix elements. However, it is known that the nuclear matrix elements found empirically are not in agreement with the theoretical value predicted by a simple shell model picture. In this work, the RaE decay is re-investigated using the recent data of electron longitu inal polarization. This re-analysis leads to an even larger disag ment between the shell prediction and the experimentally determined nuclear matrix elements. The possible origins of this disagreement are discussed from several viewpoints, and a new of collective motion is briefly discussed. This type of collective motion is important only for the beta-decay matrix element, $\int$ r.

19398 β- AND γ-SPECTRA OF Te^{117}.

N.A.Vartanov, Ya.A.Ryukhin, I.P.Selinov, V.L.Chikh and D.E.Khulelidze.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1, 303 (July, 1961).
In Russian.

A scintillation spectrometer study of the Te^{117} γ-spectrum showed lines at 0.71, 0.93, 1.10, 1.27, 1.42, 1.70, 1.98, and 2.3 M together with annihilation radiation, and the total intensity of all γ-transitions was 0.3 that of the 0.71 MeV line. The upper limit of the β^+-spectrum was 1.80 ± 0.07 MeV, and lines found in the conversion spectrum were identified as the K- and L-conversion lines of a γ-transition with energy 0.720 ± 0.004 MeV. The autho deduce that the β^+-transition is allowed, and that its multipolarit is M1 or E2. [English translation in: Soviet Physics—JETP (US

J.E.G

19399 ON THE USE OF BREMSSTRAHLUNG FOR THE DETERMINATION OF TRITIUM [BETA RADIOACTIVITY] IN AQUEOUS AND ORGANIC SYSTEMS.

T.Westermark, L.Devell and N.A.Ghanem.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 141-4 (Nov., 1960).

The bremsstrahlung method for the determination of beta ra activity without gamma radiation is extended to the case of tritiu Using cells made from light materials, excellent results and rou agreement with theoretical estimates were obtained for water containing millicurie amounts of tritium. Applications to self-diffusion studies on water and labelling experiments are briefly described.

19400 NOTE ON THE DETERMINATION OF TRITIUM [BE RAY DECAY] BY MEANS OF LIQUID SCINTILLATO AND D.C.-MEASUREMENTS OF PHOTOMULTIPLIER CURREN

T.Westermark, B.Grapengiesser, H.Lindroth and N.Ghanem.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 3, 357-9 (Dec., 1960).

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PRODUCTION OF MONOENERGETIC POSITRONS IN THE DECAY OF Eu^{152}.

asilenko, M.G.Kaganskii, D.L.Kaminskii and S.F.Koksharova.
ksper teor. Fiz. (USSR), Vol. 39, No. 4 (10), 970-2
, 1960). In Russian.

The production of monoenergetic positrons may occur in the xcitation of the 1531-keV excited state of Sm^{152}, which is formed e decay of Eu^{152}. Measurements show that the probability for process is less than 10^{-8} positrons per decay. According to alculations of Sliv (1949), this yields for the 1531 keV excited of Sm^{152} a lifetime exceeding 10^{-14} sec, which points to the ctive character of this level. [English translation in: Soviet ics—JETP (USA), Vol. 12, No. 4, 672-3 (April, 1961)].

402

SUPERALLOWED POSITRON DECAY IN K^{38m}, Sc^{42} AND Ti^{43}.

J.Jänecke and H.Jung.
hys. (Germany), Vol. 165, No. 1, 94-8 (1961). In German.

The maximum energies and the half-lives of three short-lived tivities near A = 40 were measured with a scintillation tor. The maximum β^+-energies are 5.00 ± 0.07 MeV (K^{38m}), ± 0.10 MeV (Sc^{42}) and 5.81 ± 0.15 MeV (Ti^{43}), in agreement the predictions of a semiempirical formula.

9403

THE β^+ SPECTRUM OF Si^{27}.

S.S.Vasil'ev and L.Ya.Shavtvalov.
ksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1221-3 (Nov.,
). In Russian.

The spectrum was investigated with a magnetic-lens ectrometer. End points were observed at 3.65 and 1.45 MeV intensities 90% and 10%, respectively. [English translation in: t Physics—JETP (USA), Vol. 12, No. 5, 851-2 (May, 1961)].

9404

A STUDY OF BETA—GAMMA DIRECTIONAL CORRELATION IN THE DECAY OF Au^{199}.

El-Nesr and R.Othaz.
ear Phys. (Internat.), Vol. 27, No. 3, 507-15 (Oct., 1961).

The directional correlation between the 302 keV beta-group he 158 keV gamma-ray was measured as a function of the gy of the beta-particles. A magnetic lens beta-ray spectro- r was used to select the energy of the beta-rays. Measure- s were made at the five beta-energies 89, 127, 164, 187 and eV. The directional correlation between the 251 keV beta- p and the 208 keV gamma-ray was also studied. Within the stical accuracy of the data the correlations are isotropic.

9405

ISOSPIN CONSERVATION AND β—γ CIRCULAR-POLARIZATION CORRELATION.

Bloom and L.G.Mann.
erford Jubilee Conference, Manchester, 1961 (see Abstr. 16610
961), Paper C7/8, p. 733-4.

The β—γ circular-polarization angular correlation was measured x mixed transitions: Na^{24}, A^{41}, Sc^{44}, Sc^{46}, Mn^{52} and Cs^{134}. Measure- ts were made using the method of rapid alternation plus cali- ion interlacing runs on Na^{22} and Co^{60} sources, regarded as n standards in the (A—V) theory. In the first five of these s the results indicate a Fermi matrix-element which is very ll or vanishing. The case of Cs^{134} constitutes the only definite ence found so far for a non-zero interference effect, but the e log (ft) value of 8.8 again suggests a very small (though non-) Fermi matrix-element.

9406

BETA—GAMMA DIRECTIONAL CORRELATION IN Rb^{86}.

J.H.Hamilton, B.G.Pettersson and J.M.Hollander.
Fys. (Sweden), Vol. 19, Paper 17, 249-57 (1961).

The directional correlation of the once-forbidden, non-unique keV beta-group with the 1.08 MeV gamma-ray in the decay of was measured as a function of beta-energy from 100 keV to keV. A magnetic lens spectrometer was used for energy ction of the beta-particles. The maximum anisotropy measured 0 keV is A = 0.40, which is much higher than the value rted earlier by Stevenson and Deutsch (Abstr. 8937 of 1951). nalysis of the beta-transition is made in terms of the dified B_{ij} approximation".

9407

GAMMA—GAMMA ANGULAR CORRELATION MEASUREMENTS IN Gd^{152}.

Z.Grabowski.
Fys. (Sweden), Vol. 20, Paper 11, 177-82 (1961).

The gamma—gamma angular correlation of three cascades e investigated. The measured cascades are 1280—344, 1100—344 and 790—344 keV. The measurements give the following spin assignments of the energy levels in Gd^{152}: 1625 keV 2^-, 1445 keV 3(+) and 1134 keV 3^-.

19408

MAGNETIC DIPOLE TRANSITIONS IN EVEN—EVEN NUCLEI WITH QUADRUPOLE COLLECTIVE EXCITATIONS.

D.P.Grechukhin.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1732-7 (June, 1961).
In Russian.

It is shown that for collective models with quadrupole excitations the probability ratio and interference phase shift of M1 and E2 radiation in a mixed M1 + E2 transition do not depend on the concrete structure of the collective nuclear models. The ratio of the quantities

$$\delta^2(M1/E2) = W(M1;\ I_1 \to I_2)/W(E2;\ \to I_1 \to I_2)$$

for two different M1 + E2 transitions of a given nucleus is a function only of the transition energies and nuclear spin states involved in the radiation process. By comparing this quantity with the experimental data, one can estimate to what extent the collective degrees of freedom are smeared out with increase of the excitation energy of the nucleus. [English translation in: Soviet Physics—JETP (USA)].

19409

CALCULATION OF PROBABILITIES OF M3 TRANSITIONS AND SECOND-FORBIDDEN BETA TRANSITIONS IN THE NILSSON MODEL.

D.Bogdan.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 801-8 (March, 1961).
In Russian.

Expressions are obtained for the probabilities of M3 transitions and for second-forbidden beta transitions of pure Gamow—Teller type. The specific examination of the M3 transitions which are known in deformed nuclei indicates that the use of the corrected Nilsson representation is not necessary in these cases. A study of low-probability M3 transitions and second-forbidden beta transitions shows however that sometimes, when certain definite selection rules are satisfied, the use of the corrected Nilsson representation increases the transition probability by approximately a factor of two. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 563-7 (Sept., 1961)].

19410

ANGULAR CORRELATION MEASUREMENTS ON Hf^{180} AND THE DETERMINATION OF THE g_R FACTORS OF THE 2^+ AND 4^+ ROTATIONAL STATES.

E.Bodenstedt, H.J.Kőrner, E.Gerdau, J.Radeloff, C.Günther and G.Strube.
Z. Phys. (Germany), Vol. 165, No. 1, 57-71 (1961). In German.

The following correlations in the decay of Hf^{180m} were measured:

215 keV—93 keV $\gamma\gamma$-cascade:

$$W(\vartheta) = 1 + (0.093 \pm 0.007)\ P_2 + (0.014 \pm 0.009)\ P_4$$

332 keV—215 keV $\gamma\gamma$-cascade:

$$W(\Theta) = 1 + (0.090 \pm 0.010)\ P_2 + (0.006 \pm 0.010)\ P_4$$

501 keV—332 keV $\gamma\gamma$-cascade:

$$W(\vartheta) = 1 + (0.004 \pm 0.007)\ P_2 - (0.002 \pm 0.012)\ P_4.$$

Liquid sources of HfH_4 dissolved in concentrated HF were used. The angular correlation of the 215 keV—93 keV cascade was found to be slightly attenuated by internal fields. A measurement of the differential angular correlation for different delays gave $\lambda_2 = (0.073 \pm 0.036) \times 10^9\ sec^{-1}$, assuming $A_2(t) = A_2(0) \times e^{-\lambda_2 t}$. The above correlation functions agree with the interpretation of the low lying states of Hf^{180} as a (0^+, 2^+, 4^+, 6^+) rotational band. The 501 keV—332 keV angular correlation shows that the multipolarity of the 501 keV γ-transition is a mixture of (3.5 ± 0.5)% M2 and (96.5 ± 0.5)% E3. The rotation of angular correlations in a strong external magnetic field was observed and the gyromagnetic ratios of the 2^+ and the 4^+ rotational states were determined as: g_R (2^+ level) = + 0.371 ± 0.032 and g_R (4^+ level) = + 0.5 ± 0.1.

19411

THE DECAY OF A^{37} BY ELECTRON CAPTURE.

C.Manduchi and G.Zannoni.
Nuovo Cimento (Italy), Vol. 22, No. 3, 462-70 (Nov. 1, 1961).
In Italian.

The L and K X-radiations of Cl^{37} resulting from orbital-electron capture were studied using a special multiwire proportional counter system. The L/K-capture ratio of A^{37} was determined to be 0.0971 ± 0.0005. The average energy of the L peak was found to be (254 ± 2) eV.

19412 THE K AUGER SPECTRUM OF Eu. T.Suter and P.Reyes-Suter.
Ark. Fys. (Sweden), Vol. 20, Paper 24, 393-8 (1961).

The K Auger spectrum of Eu resulting from the decay of Sm^{153} was studied with an iron-yoke double-focusing spectrometer. Energies and intensities are given and compared with theory. The value 0.908 ± 0.007 was obtained for the fluorescence yield.

19413 CONVERSION COEFFICIENT ON K-SHELL OF 88.3 keV TRANSITION IN Hf^{176}. I.Rezanka, J.Frana and J.Adam.
Czech. J. Phys., Vol. 11, No. 8, 611-13 (1961).

Reports a new value of 1.25, in agreement with McGowan's value of 1.31. R.H.Thomas

19414 A DETERMINATION OF THE K-CONVERSION COEFFICIENT OF THE 6.1 SEC M4 TRANSITION IN Pb^{203}. L.Persson and R.Stockendal.
Ark. Fys. (Sweden), Vol. 19, Paper 20, 303-7 (1961).

The K-conversion coefficient of the 825.2 keV M4 transition in Pb^{203} was remeasured by comparing the K X-ray and gamma-ray intensities in the decay of the 6.1 sec isomeric state. The scintillation spectrum was measured with an improved technique in which two multichannel analysers were utilized, one for the X-rays, the other for the isomeric gamma ray. The resulting value of $\epsilon_K = 0.22 \pm 0.02$ is in good agreement with theory($\beta_4 = 0.22$).

19415 K- AND L-ELECTRON CAPTURE PROBABILITIES AND THE DECAY ENERGY OF Pb^{203}.
L.Persson and Z.Sujkowski.
Ark. Fys. (Sweden), Vol. 19, Paper 21, 309-22 (1961).

K X-ray spectra in coincidence with the gamma-rays from the first and the second excited states of Tl^{203} were studied using scintillation techniques and an isotope-separated sample. The L_I/K capture ratio was deduced and the decay energy calculated according to the theory of Brysk and Rose (Abstr. 1738 of 1959). The total electron-capture decay energy was found to be 817^{+12}_{-10} keV. Single spectra of the L and K X-rays were measured and their ratio compared with theory. The Coster—Kronig yield $f_{L_I L_{III}}$ was deduced. The half-life of Pb^{203} was remeasured and found to be 52.1 ± 0.2 hr. The log ft values for the decay to the first and the second excited states was determined, using known branching ratios.

19416 THE K- AND L-AUGER SPECTRUM OF URANIUM. R.G.Albridge and J.M.Hollander.
Nuclear Phys. (Internat.), Vol. 27, No. 4, 554-60 (Nov., 1961).

Measurements were made of the K- and L-Auger electron spectrum of uranium, which results from the beta decay of Pa^{233}. These data are presented and compared with previously known information on the Auger transitions in heavy elements. Low-energy lines, including Coster—Kronig transitions in the energy range 0.9 to 4 keV, were observed by means of a permanent-field electron spectrograph with source pre-acceleration.

19417 DATA SHEET NO. 43 — FORTY-TWO GAMMA SPECTRA OF SHORT-LIVED NUCLIDES. M.Okada.
Nucleonics (USA), Vol. 19, No. 9, 79-81 (Sept., 1961).

Spectra of forty-two nuclides with half-lives from 1 sec to 6 min, measured with an NaCl:Tl crystal of 12% resolution at 660 keV, are presented graphically as an aid to analysis by neutron activation. R.D.Smith

19418 PRODUCTION OF THE RADIOACTIVE ISOTOPE Kr^{85} AND MEASUREMENT OF ITS γ-RADIATION.
I.E.Nakhutin, V.V.Ovechkin, D.V.Ochkin, A.S.Polyakov and Z.K.Khoduleva.
Zh. eksper teor. Fiz. (USSR), Vol. 39, No. 4 (10), 991-2 (Oct., 1960). In Russian.

Kr^{85} was obtained from neutron-irradiated uranium by frontal chromatography of the gases evolved during a solution of the uranium in nitric acid. The Kr^{85} thus obtained was used to determine the γ-ray yield. The γ-ray quantum yield is $(0.41 \pm \pm 0.06)$ % per decay, which is much smaller than the value given by Zeldes et al. (Abstr. 972 of 1951). [English translatio
in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 687-8 (April,
1961)].

19419 HIGHER-ENERGY GAMMA RAYS IN THE DECAY O
NEPTUNIUM-239. R.D.Connor and D.R.MacKenzie
Canad. J. Phys., Vol. 39, No. 11, 1595-9 (Nov., 1961).

In the decay of Np^{239} only two γ-rays with energies in exces
335 keV have been detected. These have energies of 440 ± 10 a
490 ± 10 keV and intensities of $3.6 \pm 0.9 \times 10^{-5}$ and $2.0 \pm 0.5 \times$
photons per disintegration respectively. A search at high resol
failed to reveal the associated conversion lines in the β-spectru

19420 DIRECTIONAL CORRELATION OF THE 769—609 k
GAMMA-RAY CASCADE IN Po^{214}.
H.W.Taylor and R.McPherson.
Canad. J. Phys., Vol. 39, No. 8, 1235-9 (Aug., 1961).

Describes measurements made to investigate the proposed
2+ spin assignment of the 1378 keV level of Po^{214}. Angular cor
tion measurements of the 769—609 keV gamma cascade tend to
confirm the 2+ assignment. The nature of the 1281 keV level is
uncertain. R.H.Th

19421 DETERMINATION OF THE RELATIVE INTENSITIE
THE GAMMA RAYS FROM THE DECAY OF Ta^{182} B
THE EXTERNAL CONVERSION METHOD. H.Ryde and Z.Sujkow
Ark. Fys. (Sweden), Vol. 20, Paper 18, 289-321 (1961).

The Ta^{182} decayed to W^{182}. The photoelectrons from uraniu
converters were analysed in a double-focusing beta-ray spectro
meter. To obtain the relative gamma-ray intensities, correctio
the angular dependence of the photoelectric process were applie
according to the method of Hultberg. Corrections for self-abso
in the source are considered, and their importance in the low-energy region is emphasized. Special experiments with three sources of different thicknesses were carried out to check the calculated corrections for the self-absorption. K conversion coefficients are calculated using the relative intensities of the internal conversion lines from other work. The experimentally obtained data are compared with the predictions of the unified
nuclear model and the Davydov—Filippov (Abstr. 1722 of 1959) t
for non-axially symmetric, even nuclei.

NUCLEAR REACTIONS

(Including scattering by nuclei)

19422 OPTICAL MODEL WAVE FUNCTIONS FOR STRON
ABSORBING NUCLEI. N.Austern.
Ann. Phys. (USA), Vol. 15, No. 3, 299-313 (Sept., 1961).

The extent to which nuclei can appear "black" is discussed
and shown to be limited. WKB calculations are shown to be esp
ally suitable in the case of strong absorption, and to explain ma
detailed features of exact calculations. It is seen why direct re
action calculations sometimes show the oscillatory angular dist
butions which are characteristic of "surface reactions". Study
the wave-function just outside the nuclear surface leads to a mo
for the scattering amplitudes for a strongly absorbing nucleus,
mitting a physically-based smoothing of the "sharp-cutoff mode

RELATIVISTIC GENERAL THEORY OF REACTIONS OF T
$a + b \rightarrow c + d + e + \dots$ TYPE. See Abstr. 19126

19423 GROSS STRUCTURE IN REACTIONS OF DEFORME
NUCLEI. R.A.Peck, Jr.
Nuclear Phys. (Internat.), Vol. 27, No. 4, 596-605 (Nov., 1961).

The Nilsson model is applied to determine the effect of nuc
deformation on gross structure in direct reaction spectra amon
intermediate nuclei. While the gross structure known for sphe
nuclei is obscured to low-resolution observations, it is replac
an equally distinctive pattern whose major features are fixed re
to single nucleon levels in the undeformed well. Definite minim
the spectrum persist at magic number gaps even for fairly larg
deformations. Location of the gross structure pattern on a nuc
excitation scale is determined by deformation and nucleon popu

pers, so that shifts of the structure among spectra of neigh-
ing nuclei are definite and predictable. The angular distribution
ch part of the spectrum should be dominated by a few specific
values even though the single-particle l is not a quantum
per and parities are mixed. The effects are illustrated
erically with respect to the (n,p) reaction on target nuclides of
n and Sb.

9424 COLLECTIVE EFFECTS IN INELASTIC SCATTERING FROM NUCLEI. W.T.Pinkston and G.R.Satchler.

ear Phys. (Internat.), Vol. 27, No. 2, 270-83 (Oct., 1961).
It is shown how inelastic scattering is closely analogous to an
ric multipole radiative transition, and will show similar
ctive enhancement. This enhancement will vary with scattering
. In general, spin-flip transitions are little affected, the
ncement being found in the spin-independent amplitudes; the
equences of this are discussed. The deformed-nucleus model
^{12} is used to illustrate these effects. Finally, the interaction
factors to be used for inelastic scattering are discussed.

9425 ANGULAR DISTRIBUTION OF ELASTICALLY SCATTERED 14.5 MeV NEUTRONS.

trizhak, V.V.Bobÿr and L.Ya.Grona.
ksper. teor. Fiz. (USSR), Vol. 40, No. 3, 725-8 (March, 1961).
ssian.
The differential cross-sections for elastic scattering on silver,
cury, and bismuth were measured. Neutrons from the T(d,n)α
tion were scattered from spherical targets and counted in coin-
ce with the accompanying α particles by means of a pulse
t-time analyser with a resolving time of 5×10^{-9} sec. The
rimental differential cross-sections are compared with cross-
ons calculated on the basis of the optical model. [English
lation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 506-8
., 1961)].

9426 DIRECT INTERACTION WITH STRONG COUPLING IN NUCLEAR COLLISIONS. II. E2 EXCITATIONS.

O.Mohr.
. Phys. Soc. (GB), Vol. 78, Pt 5(i), 641-9 (Nov. 1, 1961).
The work of a previous paper (Abstr. 4087 of 1960), on the
t of coupling between elastically and inelastically scattered
s for the case of E0 excitations of the nucleus throughout its
ne was extended to E2 excitations. The inclusion of coupling
es inelastic cross-sections to deviate even more from the
rted wave values for E2 excitations than for E0 excitations.
effect is greater for a volume interaction than for a surface
action of equivalent strength.

9427 CLUSTER MODEL INTERPRETATION OF ENERGY WIDTH VARIATIONS NEAR THRESHOLD.

Phillips and T.A.Tombrello.
erford Jubilee Conference, Manchester, 1961 (see Abstr.
0 of 1961), Paper C 3/14, p. 417-18.
The cluster model predicts that the level reduced width, or the
gth function for nuclear states, should attain large values near
shold and diminish above threshold in a calculable manner.
surements of hundreds of proton elastic scattering resonances
he targets Cr^{50}, Cr^{52}, Fe^{54}, and Ni^{58} in the energy region 2 to
V allow comparison with the model; these give good agreement
the data. Available published light element reaction partial
s also compare favourably in those cases where two or more
nels are open. Thus extant experimental evidence shows that
s of high two-body cluster purity tend to occur near threshold.

9428 CLUSTER EFFECTS IN NUCLEAR REACTIONS. H.D.Holmgren and E.A.Wolicki.

erford Jubilee Conference, Manchester, 1961 (see Abstr. 16610
61), Paper C5/27, p. 541-2.
Studies of nuclear reactions induced by mass-3 particles
ose large variations in the values of the absolute cross-sections
lso striking differences in the energy and angular variations of
ifferential cross-sections from one reaction to another. The
anism of each nuclear reaction appears to depend intimately
the structure of the nuclei involved. The cluster expansion of
ar wave-functions appears to be particularly useful for many
tions. Expressions for the cross-section in the direct approxi-
on limit are given using this expansion. Some reactions appear
oceed by a cluster-exchange interaction.

19429 DIRECT NUCLEAR REACTIONS WITH POLARIZED TARGETS. G.R.Satchler.

Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/29, p. 545-6.

The advantages and interpretation of nuclear reaction studies with polarized target nuclei are discussed, with particular reference to direct reactions.

19430 FINITE-RANGE DISTORTED-WAVES CALCULATION OF DIRECT REACTIONS.

E.C.Halbert, R.M.Drisko, G.R.Satchler and N.Austern.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/34, p. 555-6.

Current distorted-wave Born-approximation calculations of direct nuclear reactions employ a zero-range interaction or an equivalent approximation. An improved distorted-wave calculation is made which correctly treats finite-range interactions or finite-size projectiles.

19431 CORRELATIONS BETWEEN INCOMING AND OUTGOING POLARIZATION IN DIRECT REACTIONS.

L.J.B.Goldfarb and R.C.Johnson.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/46, p. 579-80.

A study is made of the various correlations which can be made between the polarizations of incoming and outgoing beams in direct reactions such as deuteron stripping and the stripping of two nucleons. Attention is given to some of the effects of spin-dependent distortion of the incoming and outgoing waves.

19432 ANALYSIS OF THE ANGULAR DISTRIBUTION OF REACTION PRODUCTS IN LIGHT NUCLEI.

B.L.Birbrair.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 895-7 (March, 1961).
In Russian.

Measurement of the angular distributions at energies $E_{\pm} = E_r \pm \frac{1}{2}\Gamma_r$ and $E_0 = E_r$, where E_r and Γ_r are the isolated resonance energy and width, respectively, permits one to separate the contribution of the direct mechanism to the reaction cross-section. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 626-7 (Sept., 1961)].

19433 ANGULAR CORRELATIONS IN STATISTICAL NUCLEAR REACTIONS. V.M.Strutinskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1794-802 (June, 1961).
In Russian.

The correlation between the directions of emission of particles emitted in succession by a nucleus with a large angular momentum is considered. Simple analytical expressions are obtained for the angular correlation of two particles under the condition that the final nucleus remains in a state with a small angular momentum. The correlations between the directions of emission of a particle and of the fission fragments accompanying the particle emission are also considered. [English translation in: Soviet Physics—JETP (USA)].

19434 EFFECT OF SUPERFLUIDITY OF ATOMIC NUCLEI ON STRIPPING AND PICK-UP REACTIONS.

B.L.Birbrair.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 894-7 (Sept., 1961).
In Russian.

Formulae for stripping and pick-up reactions in the forward hemisphere are derived by taking into account superfluidity of atomic nuclei. The nuclear model proposed can be verified by comparing the results with the experimental data. [English translation in: Soviet Physics—JETP (USA)].

Due to Photons

19435 ELASTIC SCATTERING OF GAMMA QUANTA BY NUCLEI.

L.I.Lapidus and Chzhou Guan-chzhao [Chou Kuang-chao].
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1056-8 (Oct., 1960).
In Russian.

The energy dependence of the cross-section for elastic scattering of γ-quanta near the photonuclear threshold is investigated with the help of dispersion relation for forward scattering. The first peak in the scattering cross-section is attributed to dispersion effects. Experiments required for a more detailed analysis are discussed. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 735-7 (April, 1961)].

19436 INELASTIC SCATTERING OF PHOTONS ON Rh^{103} NUCLEI. O.V.Bogdankevich, L.E.Lazareva and A.M.Moiseev.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1224-8 (Nov., 1960). In Russian.

The yields of the reaction $Rh^{103}(\gamma,\gamma')Rh^{103m}$ were measured by the induced-radioactivity method for various maximum bremsstrahlung energies between 5.9 and 25.5 MeV from a 30 MeV synchrotron. In this energy range the cross-section for the reaction was calculated from the yield curve by the method of Penfold and Leiss (Abstr. 10123 of 1959). The cross-section has two peaks, one at 9.3 MeV near the threshold of the (γ,n) reaction, and the second at ~ 20 MeV. The peak cross-section values are respectively 4.8 and ~ 2.5 mb. The ratio of the radiative and neutron widths is estimated. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 853-6 (May, 1961)].

19437 FAST PHOTONEUTRONS FROM SOME ELEMENTS. L.A.Kul'chitskii and V.Presperin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4 (10), 1001-4 (Oct., 1960). In Russian.

Investigates the angular distributions of photoneutrons of energy $\sim > 10$ MeV produced by irradiating lithium and iodine with bremsstrahlung of 90 MeV peak energy. The distribution was found to be highly asymmetric with respect to the angle 90^0, most of the neutrons being emitted at small angles. The energy distributions of the neutrons and protons, measured with the same apparatus, were compared. The yields of fast photoneutrons from some elements were measured. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 696-8 (April, 1961)].

19438 THEORY OF PHOTONUCLEAR REACTION ON LIGHT NUCLEI WITH EMISSION OF DEUTERONS. G.M.Shklyarevskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1031-8 (Oct., 1960). In Russian.

A theory of the (γ,d) reaction on light nuclei is developed within the framework of the independent-pair model in the small correlator approximation. The mechanism of excitation of the product nucleus through rapid variation of the self-consistent field of the nucleus in the emission of a pair of nucleons is considered, and the probability of excitation in the region of the continuous spectrum is calculated for the case of independent particles. Correct values for the (γ,d) cross-sections on light nuclei and the shapes of the energy spectra and angular distributions can be obtained by using the literature values of the parameters involved in the theory. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 717-22 (April, 1961)].

19439 PRODUCTION OF TWENTY-ONE NEW SHORT-LIVED ISOMERS BY PHOTONUCLEAR REACTIONS. H.Krehbiel and U.Meyer-Berkhout.
Z. Phys. (Germany), Vol. 165, No. 1, 99-120 (1961). In German.

Irradiation of 28 selected elements with 22.5 MeV bremsstrahlung led to the production of numerous short-lived isomeric states by photonuclear reactions. At least 21 of the observed isomeric transitions seem not to have been reported in previous literature. The energies and half-lives of the observed transitions were measured using a conventional scintillation spectrometer. The half-lives of the newly discovered isomeric states are in the region between 5×10^{-6} and 6×10^{-2} seconds. Isotope assignments and multipolarities of the observed transitions have not yet been established.

COLLECTIVE MOTION IN GIANT PHOTONUCLEAR RESONANCE. See Abstr. 19334

19440 PHOTO-DISINTEGRATION BELOW THE GIANT RESONANCE. I-II. E.Guth, N.C.Francis and D.T.Goldman.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/41, p. 567-8, 569-70.

The model-independent, Gell-Mann, Goldberger and Thirring dispersion relation is applied to the photodisintegration of Be^9. The optical-model treatment of the photodisintegration of Be^9 and of C^{13} by the authors is related to experimental and theoretical work subsequent to the publication of their theory. Recent experiments by Jakobson show peaks in the $Be^9(\gamma,n)$ cross-section at the levels 1.8, 2.43 and 3.2 MeV with angular distributions indicated by the theory. Explicit angular distributions and polarizations are obtained for C^{13}. For Be^9 the same calculations are under way.

19441 ROLE OF NUCLEON CLUSTERS IN DEEP PHOTODISINTEGRATION OF LIGHT NUCLEI. V.V.Balashov and V.N.Fetisov.
Nuclear Phys. (Internat.), Vol. 27, No. 2, 337-43 (Oct., 1961).

Elucidates the general properties of the manifestation of nucleon clusters in photonuclear reactions and gives a theoretical interpretation, in good agreement with experiment, of the reactio $C^{12}(\gamma,pt)2\alpha$. Discusses the use of deep photodisintegration for investigating the internal nuclear shells.

19442 TWO-BODY FORCES AND THE GIANT RESONANCE IN PHOTONUCLEAR REACTIONS. V.V.Balashov, V.G.Shevchenko and N.P.Yudin.
Nuclear Phys. (Internat.), Vol. 27, No. 2, 323-36 (Oct., 1961).

Partial cross-sections as well as energy and angular distributions of photodisintegration products of the Ca^{40} nucleus are calculated using the shell model. It is shown that the use of empiric data on the levels of the adjacent nuclei and the account of nucleon nucleon interactions make it possible to describe satisfactorily th photodisintegration of the giant resonance region.

COHERENT AND INCOHERENT NUCLEAR π^0 PHOTOPRODUCTION. See Abstr. 19232

19443 THE RELATIVE DEUTERON/PROTON YIELD FROM 45 MeV BREMSSTRAHLUNG IRRADIATION OF COPPER. G.P.Ho and E.L.Iloff.
Nuclear Phys. (Internat.), Vol. 27, No. 2, 234-47 (Oct., 1961).

A new method was developed and used to measure the photo-proton ratio for copper irradiated with 45 MeV maximum energy bremsstrahlung. The photo-particles leaving the 50 μ thick targe were deflected by a magnetic field in an evacuated chamber and were detected with nuclear emulsion plates. The particles were identified by using their ranges in emulsion and angles of entranc retrace their paths back to the target. Of the 1614 tracks detecte 1134 were due to particles from the target. Of these 1114 were identified as protons and only 20 were found to be deuterons, givi a deuteron to proton ratio of 0.018 ± 0.009. This result is not in agreement with the much larger values found for this ratio by ot investigators using nuclear emulsion grain-counting techniques a a magnetic cloud chamber method.

Due to Electrons

19444 ELECTRON—NUCLEUS SCATTERING AND TWO-NUCLEON CORRELATIONS. K.W.McVoy.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 166 of 1961), Paper C 1/12, p. 161-2.

If the electrons scattered inelastically by a nucleus are summ appropriately over all energy transfers at fixed momentum trans a function S(q) is obtained which depends on the momentum transf and which is determined by the Fourier transform of the ground state two-particle correlation function. For O^{16}, it is found that Pauli or exchange correlations in a shell-model wave-function depress S(q) by an amount which reaches a maximum of 30% at q ~ 200 MeV/c, but the further introduction of hard-core correlations does not perturb S(q) from the shell model function by more than 5% at any q.

Due to Nucleons

19445 GAMMA-RAYS FROM INELASTIC SCATTERING OF HIGH ENERGY NUCLEONS. A.B.Clegg and G.R.Satchler.
Nuclear Phys. (Internat.), Vol. 27, No. 3, 431-47 (Oct., 1961).

It is shown that the angular distribution of de-excitation gamma-rays following the inelastic scattering of high-energy nucleons by nuclei can give additional information on both nuclea cture and the effective interaction. Formulae are derived using mpulse approximation; distortion effects due to elastic tering of incident and outgoing nucleons are included. A simple is first discussed in terms of individual scattering amplitudes, the general formalism is introduced. The effect on the angular ribution of using polarized incident nucleons is also described shown to give further information about the scattering inter- on.

9446 ANGULAR CORRELATIONS DURING INELASTIC SCATTERING OF HIGH-ENERGY NUCLEONS.

Visotskii.
eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1399-1403 (May, 1961).
ussian.

Angular correlations in inelastic scattering of high-energy eons on nuclei with zero spin and zero isotopic spin are nined. The calculation is carried out in the impulse approxima- at small angles. It is shown that the correlation function and lependence on the nucleon scattering angle is mainly determined ne parity and isotopic spin of the excited level. [English slation in: Soviet Physics—JETP (USA)].

QUASI-ELASTIC NUCLEON—NUCLEUS SCATTERING AT H ENERGY. See Abstr. 19187

9447 REACTION CROSS-SECTIONS AND THE SHAPE OF THE IMAGINARY PART OF THE OPTICAL POTENTIAL.

.Bodmer and J.R.Rook.
erford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 961), Paper C3/2, p.395-6.

The dependence of the neutron and proton reaction cross- ions, σ_{Rn} and σ_{Rp}, on the shape of the imaginary part W(r) of optical potential was investigated for energies $\sim< 10$ MeV. It is cluded that at incident energies (typified by 4 MeV), for which absorption is moderately strong, little information can be ined, unless the shape is rather extreme, from either σ_{Rn} or separately and not very much more if these are considered ther. At higher energies ($\sim> 8$ MeV) at which the absorption is ng, information could be obtained about the surface region of) in so far as some effective extension of this is concerned.

ue to Protons

19448 ON THE SHAPE OF THE IMAGINARY PART OF THE OPTICAL MODEL POTENTIAL.

.Melkanoff, D.S.Saxon and J.S.Nodvik.
erford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 961), Paper C3/11, p. 411-12.

An indication of the shape of the imaginary part of the optical lel potential is obtained from analyses of p—C and p—Cu ttering at intermediate energies. Absolute minima are found in χ^2 deviation between calculated and experimental angular distri- ons. The shape of the χ^2 surface near the minimum provides rmation on the acceptable range of parameters. For carbon, the ume absorption is generally less than 2 MeV and the surface orption is confined to a shell less than one fermi thick. For per, the volume absorption at 17 MeV appears to be rather less 5 MeV.

19449 ROTATIONAL BANDS IN THE 1p-SHELL.

A.B.Clegg.
l. Mag. (GB), Vol. 6, 1207-13 (Oct., 1961).

It is noted that certain states of 1p-shell nuclei are strongly ited in the inelastic scattering of medium-energy protons from se nuclei while other states are weakly excited. It is suggested these observations can be understood if these nuclei are dis- ed, with rotational bands. The connection with other nuclear lels of the 1p-shell is discussed.

19450 MULTIPLE SCATTERING MEASUREMENTS IN NUCLEAR EMULSIONS EXPOSED TO MOMENTUM- LYSED PARTICLE BEAMS FROM THE CERN PROTON CHROTRON.

A.Hossain, M.F.Votruba and A.Wataghin.
vo Cimento (Italy), Vol. 22, No. 2, 308-17 (Oct. 16, 1961).

Results of multiple Coulomb scattering measurements on the tracks of high momentum particles in nuclear emulsions are described. It is shown that the method can be used to give reliable momentum estimates, for particles whose tracks are essentially flat in the emulsion, up to 25 GeV/c. Possible deviations from theoretical multiple Coulomb scattering expectations for high cell-sizes are presented.

19451 ELASTIC SCATTERING OF 8.7 BeV PROTONS ON THE NUCLEI OF PHOTOGRAPHIC EMULSIONS.

B.P.Bannik, V.G.Grishin and L.V.Sil'vestrov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1653-7 (June, 1961).
In Russian.

The angular distribution was measured. The results obtained are treated on the basis of the optical model. [English translation in: Soviet Physics—JETP (USA)].

19452 INELASTIC PROTON SCATTERING ASYMMETRIES AT 8.9 MeV.

A.Budzanowski, R.W.Clifft and B.Hird.
Nuclear Phys. (Internat.), Vol. 27, No. 2, 193-203 (Oct., 1961).

The asymmetry in the inelastic scattering of a polarized proton beam from a magnesium target was measured at a number of angles and at three different energies. A comparison between the inelastic asymmetries and the corresponding elastic asymmetries shows that in all cases they have opposite sign.

19453 INELASTIC SCATTERING OF PROTONS ON C^{12}.

V.R.McKenna and G.G.Shute.
Austral. J. Phys., Vol. 14, No. 3, 432-5 (Sept., 1961).

The main features of the inelastic scattering of protons by C^{12} are reported. Angular distributions for the process were determined at roughly 5° intervals, between 170° and 25° scattering angles, over the energy range $11\frac{1}{2}$ to 8 MeV in 100 keV steps. These distributions are illustrated graphically and the behaviour of the cross-section at fixed scattering angles for varying incident energies is obtainable from the data. These excitation functions show a resonance structure at energies corresponding to recently discovered levels in N^{13}. B.Brown

19454 POLARIZATION OF 6.8 MeV PROTONS SCATTERED ON CARBON.

M.V.Pasechnik, N.N.Pucherov, B.F.Orlenko and V.S.Prokopenko.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 915-16 (Oct., 1960). In Russian.

Experiments on double scattering of 6.8 MeV protons were performed. The large value of the polarization of protons scattered on carbon is evidence of the importance of spin—orbit interaction during scattering. An angular dependence of the polarization is noted. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 634-5 (April, 1961)].

19455 ELASTIC SCATTERING OF 6.8 MeV PROTONS ON CHROMIUM, NICKEL AND COPPER NUCLEI.

A.K.Bal'ter, I.I.Zalyubovs'kÿi, O.P.Klyucharyev, M.V.Pasichnÿk, M.M.Pucherov and V.I.Chÿrko.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 270-1 (1960). In Ukrainian.

Reports angular distributions for Cr^{52}, Cr^{53}, Ni^{58}, Ni^{60}, Ni^{62}, Cu^{63} and Cu^{65}.

19456 POLARISATION OF PROTONS ELASTICALLY SCATTERED BY Li^7 NEAR THE 441 keV RESONANCE.

J.R.Rook.
Nuclear Phys. (Internat.), Vol. 27, No. 4, 606-11 (Nov., 1961).

It is shown that the polarization effects in the elastic scattering of 441 keV protons by Li^7 depends on the ratio of the contributions of the two channel spins. The magnitude of this ratio is given by measurements on the $Li^7(p,\gamma)Be^8$ process but the sign is not determined. The polarization effects depend on this sign, being large if it is negative and small if it is positive. A shell-model calculation indicates that a fit to the energy levels of Li^8 is obtained only if the sign is positive and, together with the value of the channel spin mixing ratio, identifies the value of the intermediate coupling parameter for Be^8 which is not well determined from the energy levels. It is concluded that the polarization effects in this process are probably less than 5%.

19457 INELASTIC SCATTERING OF PROTONS BY Ne^{20} NUCLEI.

P.V.Sorokin, A.I.Popov, V.E.Storizhko and A.Ya. Taranov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1253-6 (May,1961).
In Russian.

The absolute cross-section for the reaction $Ne^{20}(p,p'\gamma)$ and the angular distributions of p' and γ corresponding to the first excited state of Ne^{20} were measured at the resonance energies 2.15 MeV and 2.72 MeV. The partial widths and reduced widths were determined for the 4.5 MeV and 5.05 MeV levels of the Na^{21} nucleus. Inelastic scattering of 2.72 MeV protons is shown to be related to a single level in the Na^{21} nucleus with a spin and parity of $\frac{3}{2}^+$ [English translation in: Soviet Physics—JETP (USA)].

19458

INELASTIC SCATTERING OF 31 MeV PROTONS FROM Ni^{60}.

H.H.Forster, D.W.Devins and G.G.Gigas.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/31, p. 549-50.

The differential cross-section for the inelastic scattering of 31 MeV protons from the first excited state of Ni^{60} was determined at laboratory angles ranging from 15° to 120° at 2° intervals. The angular distribution of the inelastically scattered protons shows evidence of a diffraction pattern with the maxima out of phase with that obtained for the angular distribution of protons scattered elastically from the same target.

19459

THE (p,p'γ) REACTION IN EVEN ISOTOPES OF Zn, Ge AND Se.

D.M.van Patter, R.Rikmenspoel and P.N.Trehan.
Nuclear Phys. (Internat.), Vol. 27, No. 3, 467-89 (Oct., 1961).

It was found possible to study the systematic properties of the second 2^+ level in medium-weight even nuclei by investigation of gamma-radiation from the (p,p'γ) reaction. For the mass region A = 60-80, the present method of observing (p,p'γ) spectra was successful for nuclei whose (p,n) threshold exceeds about 4 MeV. Measurements of the branching ratio of the second 2^+ level were made for Zn^{64}, Zn^{66}, Ge^{72}, Se^{76}, and Se^{78}, which are in reasonable agreement with available results from radioactivity. New levels were found in Ge^{70} at 1.71 ± 0.01 and 2.16 ± 0.01 MeV. The 1.71 MeV level is considered to be the second 2^+ level with a branching (cross-over/cascade) of 0.9 ± 0.1. Information concerning the excitation curves for various (p,p'γ) radiations of Zn^{66} and Ge^{70} were obtained for proton energies in the range of 3.0 to 5.2 MeV.

19460

NEUTRON YIELDS FROM THIN TARGETS BOMBARDED BY 32 MeV PROTONS.

C.N.Waddell, T.M.Henderson and P.S.Lewis.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C 1/17, p. 171-2.

Neutron yields from thin targets bombarded by 32 MeV protons were measured for 17 elements of natural isotopic abundance. The neutrons were detected in a paraffin moderated array of BF_3 counters enclosed in a 3-foot thick concrete shield. The efficiency of the neutron detection system was determined with a calibrated Ra–α–Be neutron source. Yields from monisotopic targets of Cu and Ni were measured to investigate the sharp decrease in yield previously observed with a thick Ni target. A comparison with the results of a hydrogen bubble chamber experiment is made.

19461

RECENT PRECISION DETERMINATIONS OF RESONANCE, THRESHOLD AND NATURAL α-PARTICLE ENERGIES.

A.Rytz, H.Staub, H.Winkler and W.Zych.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C 8/9, p. 783-4.

Precision energy measurement of the 991 keV resonance of $Al^{27}(p,\gamma)Si^{28}$, the $H^3(p,n)He^3$ threshold, Ni^{58} and the $Li^7(p,n)$ thresholds, and the Po^{210} α-particle are presented and compared with the results of other observers.

19462

(p,α) REACTION AND SENIORITY IN THE $f_{7/2}$ SHELL.

B.F.Bayman, F.P.Brady and R.Sherr.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/33, p. 553-4.

A study was made of the 18 MeV (p,α) reaction on targets of Sc^{45}, Ti^{48}, V^{51}, Mn^{55}, Fe^{56}, Co^{59}, Ni^{58} and Ni^{60}. The angular distributions were all found to be forward peaked. At a laboratory angle of 10°, the absolute cross-sections for the ground state transition were approximately 40, 550, 35, 18, 800, 18, 1300, 1600 mb/sterad, respectively. These exhibit a strong odd—even variation. Moreover, whereas the cross-section increases with A for even targets, it decreases with A for odd targets. These features may be qualitatively understood on the basis of a pick-up mechanism and seniority wave-functions.

19463

(p,n) REACTIONS IN MIRROR NUCLEI AND THE NUCLEAR TWO-BODY FORCE.

S.D.Bloom and N.K.Glendenning.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/37, p. 561-2.

Angular distributions and excitation curves from (p,n) reaction in certain mirror nucleus targets were obtained by a variety of techniques, including long counters, time-of-flight discrimination, and activation methods. The basic impetus for this work is the possibility of extracting the proton—neutron interaction in the vicinity of the nuclear medium in a relatively unambiguous way by interpreting the data in terms of direct-reaction theory. Results t date abundantly indicate the correctness of this point of view, both in the manifestly direct character of the data as well as in the two-body force parameters emanating therefrom.

19464

MEASUREMENT OF (p,n) REACTION Q-VALUES OF INTEREST IN β-DECAY THEORY.

J.M.Freeman and D.West.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 1661 of 1961), Paper C7/7, p. 731-2.

A new measurement of the $Mg^{26}(p,n)Al^{26*}$ Q-values is reported The value obtained is −5.017 ± 0.007 MeV corresponding to an end point for the β^+ from Al^{26*} (0^+, T = 1) of 3.212 ± .007 MeV.

19465

SINGLE PARTICLE VERSUS COLLECTIVE EXCITATION IN THE DIRECT INTERACTIONS.

T.Tamura and T.Terasawa.
Progr. theor. Phys. (Japan), Vol. 26, No. 3, 285-303 (Sept., 1961).

A detailed phenomenological analysis is made to estimate the contribution of single-particle excitations to the integrated cross-sections $\sigma(pp')$ and $\sigma(pn)$ of the (p, p') and (p, n) reactions. It is found that , if the experimentally known collective-excitation cross section is added (which is in fact added only to the former), the resulting integrated cross-sections agree very well with experime and reasonably explain why $\sigma(pp') \gg \sigma(pn)$. However, the contribution of the collective excitation to $\sigma(pp')$ is found in the analysis to be only a small fraction of $\sigma(pp')$, contrary to the supposition of Cohen that it is the main part of $\sigma(pp')$. To complement the above phenomenological analysis, somewhat more basic considerations of the direct interactions are made, using the T-matrix formalism Discussions are given concerning the description of the collective excitation in the inelastic scattering process as a superposition of single-particle excitations, in accordance with other authors, and also concerning the reason why the excitation of the collective states is expected to be small in the transmutation reactions.

PROTON–CARBON INTERACTIONS. See Abstr. 19195

19466

NUCLEAR REACTIONS FROM RECOIL PROTONS IN A REACTOR.

S.S.Glickstein and R.G.Winter.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 226-8 (Nov., 1960).

Samples of H_3BO_3, $(C_2H_4)_n$ and H_2O were exposed to the fast neutron flux next to the core of a 10^5 W "swimming pool" reactor. The reactions $B^{11}(p,n)C^{11}$, $C^{12}(p,\gamma)N^{13}$, $C^{13}(p,n)N^{13}$, and $O^{18}(p,n)F^{18}$ were initiated by recoil protons and the positron activities of the products were observed. The yields, in atoms produced per gm of sample per sec of irradiation, were 5000 for C^{11}, 800 for N^{13}, and 100 for F^{18}. The fast neutron spectrum was measured with threshold detectors, and the yields were computed. The agreement of the calculated and measured results is good.

19467

RELATIVE INTENSITIES OF GAMMA RAYS FROM TH REACTION $F^{19}(p,\alpha\gamma)O^{16}$.

L.Ask.
Ark. Fys. (Sweden), Vol. 19, Paper 14, 219-28 (1961).

The relative intensities of the 6.14, 6.92 and 7.12 MeV gamma rays were measured for proton energies up to 2.63 MeV. A three-crystal-pair spectrometer was used with an energy resolution of 4%, permitting the two 7 MeV components to be resolved.

19468

ANGULAR DISTRIBUTIONS OF α-PARTICLES FROM THE $F^{19}(p,\alpha)O^{16}$ REACTION.

I.B.Teplov, O.P.Shevchenko and É.K.Ruuge.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 923-8 (Oct., 196
In Russian.

A telescope of three proportional counters was used to measu angular distributions of α-particles from the $F^{19}(p,\alpha)O^{16}$ reaction with formation of the O^{16} nucleus in the ground state. Measuremen re made over the range of angles 20-160° for 11 energies of the ident protons between 5.1 and 6.5 MeV. All the angular distribu- ns show a marked anisotropy. The results are discussed from point of view of possible reaction mechanisms. [English nslation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 640-3 pril, 1961)].

19469 PRODUCTION OF TRITIUM IN LEAD AND ALUMINIUM BY HIGH-ENERGY PROTONS, DEUTERONS AND PARTICLES. V.V.Kuznetsov.

. eksper. teor. Fiz. (USSR), Vol.40, No. 5, 1263-9 (May, 1961). Russian.

Experimental data are presented on the production of tritium lead and aluminium by 70-390 MeV deuterons and 140-750 MeV -particles and also in zinc and cadmium by 750 MeV α-particles. ne tritium yields from aluminium and lead targets of various icknesses bombarded by 660 MeV protons are also given. nglish translation in: Soviet Physics—JETP (USA)].

19470 ANGULAR DISTRIBUTION OF THE NEUTRONS FROM THE REACTION $Li^7(p,n)Be^7$. A.Nilsson.

rk. Fys. (Sweden), Vol. 19, Paper 19, 289-301 (1961).

Distributions were measured at four proton energies between 7 and 3.5 MeV, at angles up to 150°, using a time-of-flight chnique with photographic recording of oscilloscope tracks. The ergy of the cyclotron-accelerated protons was varied by degrader ils. The detector efficiency was calibrated with the help of the $(p,n)He^3$ reaction. Some comments on the energy precision are ade in an appendix.

19471 THE γ-RADIATION OF THE $Li^7(p,\gamma)$ RESONANCE AT 441.3 keV.

.Meyer, H.Müller, H.H.Staub and R.Zurmühle.

uclear Phys. (Internat.), Vol. 27, No. 2, 284-93 (Oct., 1961).

Measurements were made of the intensity ratio, the angular istribution and the $\alpha-\gamma$ angular correlation of the resonant -radiation of the reaction $Li^7(p,\gamma)Be^8$. The results, which are in ir agreement with recent values published elsewhere, permit the etermination of the channel spin ratio and the three partial γ-ray idths of the 17.6 MeV M1 radiation and the M1 and E2 components f the 14.8 MeV transition. While the value for the 17.6 MeV omponent agrees well with calculations using the independent article model, it is shown that the partial widths of the 14.8 MeV omponents disagree strongly with the predictions of such a model. t is proposed to explain this discrepancy by the strong collective otion required by the α-particle model for the first excited state f Be^8.

19472 EXPERIMENTAL AND CALCULATED CROSS-SECTIONS OF THE REACTIONS $Bi^{209}(p,xn)Po$ FOR BOMBARDING PROTON ENERGY OF 135 MeV.

B.N.Belyaev, A.V.Kalyamin and A.N.Murin.

Dokl. Akad. Nauk SSSR, Vol. 140, No. 2, 337-9 (Sept. 11, 1961). In Russian.

Experimental values of the cross-sections for formation of Po isotopes with atomic numbers between 200 and 209, measured by studying their decay, were found to be in good agreement with theoretical values calculated on the Serber—Goldberger—Weisskopf model by a Monte Carlo method. [English translation in: Soviet Physics—Doklady (USA)]. J.E.Gore

19473 GAMMA RADIATION FROM THE MEDIUM ENERGY PROTON BOMBARDMENT OF LITHIUM, BERYLLIUM, BORON, CARBON AND NITROGEN.

A.B.Clegg, K.J.Foley, G.L.Salmon and R.E.Segel.

Proc. Phys. Soc. (GB), Vol. 78, Pt 5(i), 681-94 (Nov., 1961).

Measurements are presented of the gamma radiation produced when lithium, beryllium, boron, carbon and nitrogen are bombarded with 150 MeV protons, and the results are discussed with reference to the information they provide about the structure of the nuclei involved. The results include measurements of the residual states produced in (p, 2p) and (p, pn) reactions, which are, to a first approximation, measurements of the parentage of the ground state of the bombarded nucleus. These results are not consistent with a simple jj-coupling model of these nuclei and in one case where calculations are available, are consistent with an intermediate coupling model. It is shown that inelastic scattering cross-sections are determined by the same matrix element as radiative transitions so that inelastic scattering is a powerful tool for picking out strong radiative transitions to nuclear ground states.

19474 TOTAL NUCLEAR REACTION CROSS SECTIONS FOR 180 MeV PROTONS.

A.Johansson, U.Svanberg and O.Sundberg.

Ark. Fys. (Sweden), Vol. 19, Paper 38, 527-39 (1961).

The total nuclear reaction cross-sections for 180 MeV protons incident on Li, Be, C, Al, Ca, Fe, In and Au were measured. Range separation was used to distinguish between elastically and inelastically scattered particles and the effect of the shape of the range curve was studied. The total r.m.s. error is 2-3% and due mainly to counting statistics. The experimental cross-sections were compared with the results of a calculation using an optical model with parameters derived from the Gammel—Thaler nucleon—nucleon scattering matrix.

19475 THE ELASTIC SCATTERING OF 180 MeV PROTONS FROM NUCLEI.

A.Johansson, U.Svanberg and P.E.Hodgson.

Ark. Fys. (Sweden), Vol. 19, Paper 39, 541-79 (1961).

The differential cross-sections for elastic scattering of 180 MeV protons from lithium, beryllium, carbon, aluminium, calcium, iron, indium and gold were measured up to large scattering angles. Particular care was taken to obtain good energy resolution. The results were compared with the calculated scattering from an optical model potential with different radial extensions of the real and imaginary terms in both the central and the spin—orbit parts of the potential. Qualitative agreement was found.

19476 THE TOTAL CROSS-SECTION FOR PRODUCTION OF CARBON 14 FROM OXYGEN 16 BY HIGH-ENERGY PROTONS. M.A.Tamers and G.Delibrias.

C.R. Acad. Sci. (France), Vol. 253, No. 11, 1202-3 (Sept. 11, 1961). In French.

The total cross-sections for the $O^{16}(p, 3p)C^{14}$ reaction were determined using protons in the energy range 0.05 to 2.7 GeV. The estimation of C^{14} was effected by means of the customary dating equipment. The values for the cross-section appear to be constant at $\sigma = 2.3 \pm 0.5$ mb over the energy range measured, implying the existence of measurable quantities of the C^{14} isotope in stony meteorites. S.J.St-Lorant

19477 EMISSION OF HAMMER TRACKS FROM INTERACTIONS OF 24.8 GeV/c PROTONS WITH THE NUCLEI OF NUCLEAR EMULSION.

H.Braun, G.Baumann and P.Cüer.

C.R. Acad. Sci. (France), Vol. 253, No. 15, 1559-61 (Oct. 9, 1961). In French.

The distributions are given of the number of hammer tracks as a function of the secondary products N_h and N_g in the primary star. The energy spectrum of the fragments has a distinct high energy tail and the angular distribution is peaked in the region of 90°, both findings contradicting evaporation theory. S.J.St-Lorant

19478 THE FORMATION OF HIGH ENERGY π-MESON BEAMS. Yu.P.Nikitin, I.Ya.Pomeranchuk and I.M.Shmushkevich.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 963-8 (Sept., 1961). In Russian.

The cross-section for formation of fast π^+-mesons is calculated in collisions between high energy protons and nuclei in which a small momentum is transferred to the nucleus. Under these conditions the main part of the interaction is the exchange of virtual photons. The cross-section is therefore determined by means of available experimental data pertaining to the cross-section for photoproduction of π^+-mesons on protons. [English translation in: Soviet Physics—JETP (USA)].

Due to Neutrons

19479 OPTICAL MODEL ANALYSIS OF POLARIZATION IN NEUTRON SCATTERING AT 2.09 MeV. P.E.Hodgson.

Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C3/10, p. 409-10.

The data of Cranberg on the polarization of 2.09 MeV neutrons elastically scattered by a range of nuclei are analysed by means of the optical model. The overall features of the measurements are given by a Saxon—Woods potential with U = −45 MeV, W = −3 MeV, $U_s = 3$ MeV $-f^2$, $r_0 = 1.3$ f and a = 0.65 f.

19480 WAVE DISTORTION IN DIRECT INTERACTIONS.

L.R.B.Elton and D.F.Jackson.

Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/47, p. 581-2.

Inelastic scattering of high energy neutrons by nuclei is investigated in WKB approximation. It is found that the distortion of the scattered wave cannot be represented merely by a change in wavenumber, and that the forward scattering peak in the cross-section must be due to refraction rather than diffraction.

19481 THE INFLUENCE OF ANHARMONICITY ON THE ENERGY DISTRIBUTION OF ANELASTICALLY SCATTERED NEUTRONS I. THE CASE OF WEAK INTERACTIONS.

V.N.Kashcheev and M.A.Krivoglaz.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1528-40 (May, 1961). In Russian.

The anelastic scattering of slow monochromatic neutrons by anharmonic crystal vibrations is investigated theoretically. The dependence of the form of the frequency peaks [spikes] of coherently-scattered neutrons on the phonon wave vector and temperature, is calculated. Only the scattering of neutrons by single phonons in an ideal crystal is considered. It is pointed out that for neutrons, scattered non-coherently by harmonic interactions, pecularities in the energy spectrum are broadened, as is the case for phonon-scattering by static inhomogeneities in crystals. [English translation in: Soviets Physics—Solid State (USA), Vol. 3, No. 5, 1107-16 (Nov., 1961)]. D.J.Barber

19482 NEUTRON SPECTRA RESULTING FROM THE PASSAGE OF 14 MeV NEUTRONS THROUGH THICK LAYERS OF Fe, Pb, AND U.

Iu.S.Zamyatnin, N.I.Ivanova and I.N.Safina.

Atomnaya Energiya (USSR), Vol. 6, 466 (1959). In Russian. English translation in: Reactor Sci. (GB), Vol. 12, No. 1-2, 83-5 (May, 1960).

The effect of inelastic scattering processess on the secondary neutron spectra was investigated for the varying thickness of the three materials. It was concluded that the neutron inelastic scattering cross-section at 1 MeV incident neutron energy is 0.2 barn for Pb, 0.4 barn for Fe and 1.6 barn for U. V.M.Rout

19483 STUDIES ON THE ATOMIC NUCLEUS STRUCTURE WITH REACTOR "EWA". Z.Wilhelmi.

Nukleonika (Poland), Vol. 5, No. 7-8, 467-80 (1960).

A short report on the work planned and carried out by the I-A Department of Atomic Nucleus Physics, Institute of Nuclear Research, Warsaw. The cross-sections for potential scattering of "epi-cadmium neutrons" by several elements were measured by a transmission method [Ratynski et al., Abstr. 2216, 2218 of 1961; Institute of Nuclear Research Report No. 103/I-A (1959); No. 131/I-A (1960)]. and found to be in barns: Al (1·4 ± 0.1), Fe (8.7 ± 0.3), Co (4.9 ± 0.2), Ni (3.9 ± 0.4), Cu (6.6 ± 0.2), Zn (6.6 ± 0.2), Se (9.2 ± 0.6), Ag (5.3 ± 0.4), Bi (8.9 ± 0.4). Rough agreement with values expected from the optical model was found. The discrepancies are attributed to the non-spherical form of the nuclei, not taken into account in the model. Fission of U^{235} and Pu^{239}, followed by energetic alpha-particle emission (8-30 MeV) was studied. The energy distribution of the fission products was found to be different from that in the more common double-fission process. The relative amplitudes of the two peaks are different in the two processes, and the peaks occur in the triple-fission process at energies about 6 MeV lower than in the double-fission process. J.L.Redding

19484 INTERACTION OF 14 MeV NEUTRONS WITH NUCLEI.

P.Strohal, N.Cindro and B.Eman.

Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/42, p. 571-2.

The results of measurement and theoretical calculations for (n,2n), (n,p) and (n,α) total cross-sections for several nuclei around Z = 40 are presented. The experimental results for (n,2n) reactions are in fair agreement with the simple compound nucleus theory, while there is a sharp disagreement between theory and experiment for (n,p) and (n,α) reactions, even after inclusion of shell and pairing corrections into the theory. The effect of the closed N = 50 shell on the reaction mechanism was also investigated.

19485 NEUTRON FORCE FUNCTION IN THE OPTICAL MODEL.

Yu.P.Elagin, V.A.Lul'ka and P.É.Nemirovskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3 (9), 959-62 (Sept., 1961). In Russian.

The effect of surface absorption on the behaviour of the force function is considered for neutrons in nuclei with masses in the rang 90 < A < 130. It is shown that surface absorption does not yield any qualitatively new results compared to volume absorption and does not provide any explanation of the discrepancy between theory and experiments in this region. It is furthermore demonstrated that if spin–orbit coupling is taken into account in the calculations for deformed nuclei, an additional splitting of the force function peaks arises and the agreement between theory and experiment ca be improved in the neighborhood of the peak A ~ 150 as well as nea the peak A ~ 50. [English translation in: Soviet Physics—JETP (USA)].

19486 NEUTRON TRANSFER IN NUCLEAR COLLISIONS.

T.L.Abelishvili.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1440-5 (May, 1961). In Russian.

Neutron transfer in nuclear collisions is considered in the cas when the influence of the Coulomb field is significant. The possibility of formation of a compound nucleus at energies above the Coulomb barrier is taken into account. The differential cross-section reaches a maximum which shifts towards smaller angles with rise of the energy. The angular dependence of the cross-section depends weakly on the angular momentum of the state in which the neutron is captured. The calculation is restricted to the case when the thermal effect of the reaction is small compared wit the energy of the colliding nuclei. [English translation in: Soviet Physics—JETP (USA)].

19487 THE DISINTEGRATION OF B^{10} AND F^{19} BY FAST NEUTRONS.

E.A.Davis, F.Gabbard, T.W.Bonner and R.Bass.

Nuclear Phys. (Internat.), Vol. 27, No. 3, 448-66 (Oct., 1961).

The disintegrations were studied using a grid-type ionization chamber filled with argon and boron trifluoride enriched in B^{10}. Monoenergetic neutrons for studying the reactions from 0.2 to 8.2 MeV were produced with the $Li^7(p,n)Be^7$, $T(p,n)He^3$ and $D(d,n)He^3$ reactions. Alpha groups from the $B^{10}(n,\alpha)Li^7$ reaction leaving Li^7 in its ground and first excited state at 478 keV were studied over the entire energy range. The cross-section for the (n,α) reaction decreased rapidly from 1048 mb at 0.2 MeV to 180 mb at 1.2 MeV and then increased to 451 ± 60 mb at the 1.84 MeV resonance. For higher energies broad resonance structure was observed with the cross-section generally decreasing and reaching a value of 31 mb at 8.2 MeV. The $B^{10}(n,t2\alpha)$ reaction was observed for neutron energies above 1.3 MeV. The cross-section for this reaction increased to 80 mb at 4.5 MeV and was comparable to that for the $B^{10}(n,\alpha)Li^7$ reaction above 5 MeV. The $B^{10}(n,t2\alpha)$ reaction was found to proceed mainly by three-body breakup or through the 4.63 MeV excited state of Li^7. Some reactions may have proceeded through the 2.9 MeV level of Be^8 but few, if any, proceeded through the ground state of Be^8. The total excitation function for the $F^{19}(n,\alpha)N^{16}$ reaction leaving N^{16} in the ground and first three excited states was studied for neutron energies above 2.9 MeV. Ten resonances were observed. The cross-section increases to 135 ± 50 mb at 5.80 MeV and then decreases at higher energies.

19488 14 MeV (n,2n) CROSS-SECTIONS FOR Be, Pb AND Bi.

N.N.Flerov and K.M.Talizin.

Atomnaya Energiya (USSR), Vol. 5, 657 (1958). In Russian. English translation in: Reactor Sci. Technol. (GB), Vol. 11, No. 2-4 174-5 (Feb., 1960).

A graphite prism fast neutron detector was used to measure the (n,2n) cross-section of Be, Pb and Bi. The method used is briefly described and the calculation of the required cross-sections from the experimental data is outlined. The values of the (n,2n) cross-section for Be, Pb and Bi were 0.55 ± 0.06, 2.30 ± 0.19, and 2.42 ± 0.20 barn respectively. The values of these cross-sections obtained by other workers are also presented for comparative purposes. B.Brow

19489 THE $Cl^{35}(n,p)$ REACTION AND NEUTRON RESONANCE PARAMETERS OF CHLORINE.

Yu.P.Popov and F.L.Shapiro.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1610-14 (June, 1961).

Measurements are described of the energy dependence of the reaction cross-section for neutrons with energies up to 20 keV. Parameters of resonances at energies of 0.21, 0.405 and 4.3 keV are presented. The results are discussed together with the data previously obtained on the neutron radiative capture cross-section for chlorine. [English translation in: Soviet Physics—JETP (USA)]

19490 DIRECT INTERACTION EFFECTS IN (n, p)- AND (n, α)-REACTIONS IN CsI.

'Bormann and R.Langkau.
therford Jubilee Conference, Manchester, 1961 (see Abstr. 610 of 1961), Paper C 5/7, p. 501-2.

The (n, p)- and (n, α)-reactions induced by DT-neutrons in I were investigated using a pulse shape discrimination method th a CsI(Tl)-scintillation crystal. The energy spectra of the itted protons and alpha-particles and the cross-sections for ch reaction were measured for six different neutron energies in range 12·1 to 21·5 MeV. An analysis of the spectra and cross-ctions obtained using the statistical theory of nuclear reactions ds to the conclusion that beside evaporation processes, direct eraction mechanisms also play an essential part in the reactions vestigated.

19491 DEVIATIONS OF THE CROSS SECTIONS OF SLOW-NEUTRON REACTIONS ON LIGHT NUCLEI FROM HE 1/v LAW.

A.A.Bergman and F.L.Shapiro.
. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1270-81 (May, 1961). Russian.

The energy dependence of the cross-section ratios for the actions $Li^6(n,\alpha)$, $B^{10}(n,\alpha)$ and $He^3(n,p)$ was measured for neutron ergies $E < 30$ keV. A correction to the 1/v law was found which n be expressed as a constant term in the reaction cross-section d is respectively -0.03 ± 0.01 bn, -0.40 ± 0.03 bn and .1 ± 0.2 bn for Li^6, B^{10} and He^3. Available data on the $Li^7(p,n)$ action indicate that the constant term in the Be^7 cross-section -61 ± 7 bn. The results obtained are in good agreement with e theoretical predictions. They show that capture of slow utrons by the He^3 nucleus proceeds along the channel with 0^+ in and parity and confirm the assumption that capture of slow utrons by the B^{10} and Be^7 nuclei proceeds along channels with ins and parities of $\frac{7}{2}+$ and 2- respectively. [English translation : Soviet Physics—JETP (USA)].

19492 THE TOTAL NEUTRON CROSS-SECTION OF ^{237}Np BETWEEN 2 AND 10 000 eV.

.V.Adamchuk, S.S.Moskalev and M.I.Pevzner.
omnaya Energiya (USSR), Vol. 6, 569 (1959). In Russian. glish translation in: Reactor Sci. (GB), Vol. 13, No. 1-2, 72-4 ct., 1960).

A graph is given of the cross-section versus energy over the mplete energy range, and fifteen resonances found in the region 36 to 18.9 eV are tabulated. The spectrometer used had a aximum resolution of 0.12 μsec/m. Transmission measurements dicate a strength function of $0.68 \pm 0.13 \times 10^{-4}$ (100 eV-12 000 eV); d the resonance integral is calculated to be 360 barns .7 eV-12 000 eV).

R.A.Coombe

19493 EVAPORATION MECHANISM AND DIRECT EFFECT IN n,p REACTIONS ON MEDIUM WEIGHT NUCLEI.

.Colli, I.Iori, S.Micheletti and M.Pignanelli.
uovo Cimento (Italy), Vol. 21, No. 6, 966-79 (Sept. 16, 1961).

Energy spectra of protons emitted in (n,p) reactions with 14 MeV eutrons on 13 nuclides from P^{31} to Rh^{103} are presented. Evidence s presented for the presence of both evaporation and direct mechan-sms. By comparing the forward with backward spectra an evalua-ion of the direct effect cross-section is given.

19494 NUMERICAL CALCULATIONS OF DIRECT INTERACTION CROSS-SECTIONS FOR (n, np) PROCESSES.

.B.Hyder.
hysica (Netherlands), Vol. 27, No. 12, 1113-18 (Dec., 1961).

Cross-sections for (n, np) processes in Se, W, Ce and Pd are umerically calculated, on the basis of direct interaction theory. ross-sections at different excitations of the residual nucleus are lso calculated and are shown to have a sharp peak towards lower xcitations.

19495 INTERACTION OF 14 MeV NEUTRONS WITH A SILICON SEMICONDUCTOR NUCLEAR PARTICLE ETECTOR.

W.M.Deuchars and G.P.Lawrence.
ature (GB), Vol. 191, 995 (Sept. 2, 1961).

Brief report of reactions expected to take place. A peak at .6 MeV is assigned tentatively to the reaction $Si^{28}(n,d)Al^{27}$.

C.A.Hogarth

19496 AN INVESTIGATION OF (n, 2n) REACTIONS LEADING TO ISOMER FORMATION.

V.L.Glagolev and P.A.Yampol'skii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 743-8 (March. 1961). In Russian.

Data are presented on the cross-sections for (n,2n) reactions involving 14.7 MeV neutrons and resulting in the formation of the isomers Y^{88m}($\sigma_m > 0.4$ barn), Nb^{92g} ($\sigma_g = 0.53 \pm 0.06$ barn), Pb^{207m}($\sigma_m = 1.7 \pm 0.3$ barn), and Bi^{208m}($\sigma_m = 0.66 \pm 0.12$ barn). The cross-section for the reaction with lead was evaluated on the assumption that the isomer is produced only in the reaction $Pb^{208}(n,2n)Pb^{207m}$. This value is compared with that computed from strong-interaction theory, assuming a two-stage mechanism of neutron evaporation in the (n,2n) reaction. The Pb^{207} level scheme which agrees with the shell model was employed in the calculations. The relative probabilities of different types of transitions were estimated from the relation between the lifetime of an excited nuclear state and the transition energy. There is good agreement between the measurements and calculations. Radiation from the following isomers is reported: Nb^{92g}($T_{1/2} = 10.0 \pm 0.3$ day, $E\gamma = 0.94 \pm 0.01$ MeV), Bi^{208m}($T_{1/2} = 2.6 \pm 0.1$ msec, $E\gamma = 0.50 \pm 0.02$ MeV, $E\gamma = 0.88 \pm 0.02$ MeV), and Na^{24m} ($T_{1/2} = 18.3 \pm 0.6$ msec). [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 520-4 (Sept., 1961)].

Due to Mesons and Hyperons

INELASTIC SCATTERING OF FAST PIONS ON HELIUM.
See Abstr. 19296

19497 ON THE SPIN-DEPENDENCE OF THE INTERACTION RESPONSIBLE FOR MUON CAPTURE.

V.L.Telegdi.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper S7/3A, p. 715-17.

Experiments on the spin-dependence of muon capture by nuclei are reviewed and discussed.

TOTAL CROSS-SECTIONS FOR THE INTERACTION OF 4.75 AND 3.7 BeV/c K^+ AND π^+-MESONS WITH NUCLEI.
See Abstr. 19265

19498 ON THE EMISSION OF NEUTRAL HYPERONS FROM K^--INTERACTIONS AT REST WITH EMULSION NUCLEI.

D.H.Davis, M.Csejthey-Barth, J.Sacton, B.D.Jones, B.Sanjeevaiah and J.Zakrzewski.
Nuovo Cimento (Italy), Vol. 22, No. 2, 275-84 (Oct. 16, 1961).

A systematic search was made for decays of Λ^0-hyperons around 5262 interactions of K^--mesons at rest in photographic emulsion. From the 41 decays of correlated Λ^0-hyperons observed in this sample, it was estimated that (47 ± 7)% of all K^--meson interactions at rest in emulsion nuclei emit neutral hyperons. On consideration of the conservation of strangeness it is suggested that cryptofragments are formed in (30 ± 7)% of all such K^--meson absorptions and that the non-mesonic decays of these cryptofragments give rise to a considerable proportion of the protons of energies greater than 60 MeV emitted from K^--meson captures.

19499 THE ASYMMETRY IN THE ANGULAR DISTRIBUTION OF NEUTRONS EMITTED IN THE CAPTURE OF μ^--MESONS IN CALCIUM.

V.S Evseev, V.I.Komarov, V.Z.Kush, V.S.Roganov, V.A.Chernogorova and M.M.Shimchak.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 1, 306-7 (July, 1961). In Russian.

The angular distribution of neutrons with energies greater than 7 MeV (to exclude evaporation neutrons), leaving a 12 g cm^{-2} calcium target exposed to μ^--mesons with momentum 250 MeV/c, was measured. The coefficient of asymmetry for capture of completely polarized μ^--mesons was found to be -0.93 ± 0.33, very close to values deduced from the results of measurements on magnesium and sulphur [Abstr. 2687 of 1960 and Telegdi (1960)], and confirms the non-conservation of parity in μ^--meson capture. The value is appreciably higher than the most probable theoretical figure of 0.41. [English translation in: Soviet Physics—Solid State (USA)].

J.E.Gore

19500 CAPTURE OF μ^--MESONS BY THE O^{16} NUCLEUS.
I.S.Shapiro and L.D.Blokhintsev.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1112-14 (Oct., 1960). In Russian.

The ratio of the probabilities for μ^- capture by the O^{16} nucleus with formation of N^{16} in the 0^- and 1^- states is calculated. It is found to be strongly dependent on the effective pseudoscalar constant and can be used for its measurements. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 775-6 (April, 1961)].

19501 TRANSVERSE POLARIZATION OF Λ HYPERONS, GENERATED BY 2.8 BeV/c PIONS ON XENON NUCLEI.
I.A.Ivanovskaya, E.V.Kuznetsov, A.Prokesh and I.V.Chuvilo.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 708-9 (Feb., 1961). In Russian.

The observations were made in a xenon bubble chamber. Measurements on 148 Λ decays gave an asymmetry coefficient $\alpha\bar{P} = 0.08 \pm 0.14$. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 495-6 (Aug., 1961)]. A.Ashmore

19502 PRODUCTION OF HYPERFRAGMENTS FROM INTERACTIONS OF 800 MeV/c K^--MESONS.
B.D.Jones, B.Sanjeevaiah, J.Zakrzewski, M.Csejthey-Barth, J.P.Lagnaux, J.Sacton, M.J.Beniston, E.H.S.Burhop and D.H.Davies.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C 1/30, p. 199-200.

The emission of hyperfragments from disintegration of emulsion nuclei produced by 800 meV/c K^--mesons was studied, and preliminary results are presented.

Due to Deuterons

19503 THE POLARIZATION OF DEUTERON.
Y.Takahashi.
Progr. theor. Phys. (Japan), Vol. 26, No. 3, 315-20 (Sept., 1961).

The polarization in the elastic scattering of deuterons from spin-zero targets is treated on the basis of diffraction theory by using the polarization formalism of Wolfenstein and Ashkin (Abstr. 4139 of 1952), Lakin (Abstr. 4362 of 1955) and Stapp (Abstr. 8827 of 1957). The D-state contribution of the deuteron is small, especially for small angles, in the results of cross-section polarization for deuteron elastic scattering at 94 MeV.

19504 DOUBLE PICK-UP OF INEQUIVALENT NUCLEONS IN $C^{13}(d,\alpha)B^{11}$.
W.P.Alford, O.M.Bilaniuk and B.B.Marsh.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/32, p. 551-2.

Angular distributions of α-particles leading to the ground state of B^{11} were observed in the $C^{13}(d,\alpha)B^{11}$ reaction at deuteron energies of 3.26 and 3.45 MeV. These distributions show a prominent forward peak, suggesting that the reaction proceeds via a double pick-up mechanism. It is found that the shapes of the angular distributions are very similar to those observed in cases which can be interpreted as the transfer of a single cluster. Since, in this case, the transferred particles come from different shell-model states, it is seen that the shape of the angular distribution may be insensitive to the internal recoupling of the transferred particles.

19505 COULOMB-DISTORTED (d,p) ANGULAR DISTRIBUTIONS AS A FUNCTION OF BOMBARDING ENERGY.
D.W.Miller, H.E.Wegner and W.S.Hall.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/35, p. 557-8.

Experimental angular distributions are presented for eight proton groups from the $Pb^{206}(d,p)$ reaction over the range of bombarding energies from 8.3 to 15 MeV. When the best distorted-wave stripping theory fit is obtained to the data of one group at 14 MeV, the correct qualitative features of the angular distributions for the same group at different energies and for different groups at the same energy are generated by the computer without changing the distortion parameters. Comparison of the modest fine structure observed and computed suggests extended use of the stripping reaction for nuclear spectroscopic purposes in heavy nuclei.

19506 ANGULAR DISTRIBUTIONS OF THE $Be^9(d,n)B^{10}$ NEUTRONS.
G.C.Morrison, A.T.G.Ferguson and J.E.Evans.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 1661 of 1961), Paper C5/44, p. 575-6.

A time-of-flight technique was used to measure the angular distributions of neutrons to the ground state and first three excite states of B^{10} in the reaction $Be^9(d,n)B^{10}$ at incident deuteron energi of 2, 3 and 4 MeV. The measured distributions are very similar i form at each energy studied. At 2 MeV, the distributions exhibit approximately equal amounts of forward and backward peaking. A the energy increases, a marked increase in the amount of forward peaking with a corresponding shift to smaller angles is observed. The results are discussed on the basis of deuteron stripping theor

19507 A STUDY OF THE $C^{12}(d,n)N^{13}$ REACTION.
H.W.Fulbright and J.Verba.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 1661 of 1961), Paper C5/45, p. 577-8.

Angular distributions and excitation curves were obtained for the $C^{12}(d,n)N^{13}$ reaction near the 4 MeV resonance. General qualitative agreement with previous work on the $C^{12}(d,p)C^{13}$ reactio was found. However, a programme of least squares fitting applied to the data leads to different values of the level width and of the resonance energy, and to the speculation that another narrower resonance may also be present.

19508 A STUDY OF THE $Mg^{24}(d,p)Mg^{25}$ REACTION.
R.Middleton and S.Hinds.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 1661 of 1961), Paper C5/50, p. 585-6.

The $Mg^{24}(d,p)Mg^{25}$ reaction was studied at an incident energy of 10 MeV using the Aldermaston multi-channel magnetic spectrograph. Angular distributions of the elastically scattered deuterons and 44 proton groups were measured over the range 5° to 175°. None of the angular distributions exhibit backward peaks although 16 have strong forward peaks and these are analysed with Butler theory. A Table of l-value assignments and relative reduced width is presented.

19509 A STUDY OF THE $B^{10}(d,p)B^{11}$ REACTION AT A BOMBARDING ENERGY OF 10.1 MeV.
S.Hinds and R.Middleton.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 1661 of 1961), Paper C5/51, p. 587-8.

Angular distributions were measured of some proton groups from the $B^{10}(d,p)B^{11}$ reaction using a multi-channel magnetic spect graph. Deuterons were accelerated to an energy of 10.1 MeV in the Aldermaston tandem accelerator and measurements were made for the proton groups leading to the ground and first eleven excited states. The distributions displayed a strong variation of intensity, and the stronger ones are fitted with Butler stripping curves. An $l = 1$ assignment is made to the transition to the 8.927 MeV state of B^{11} which disagrees with a previous assignment of $l = 0 + 2$ mad by Bilaniuk and Hensel.

19510 ANALYSIS OF THE $l_n = 1$ GROUPS IN THE REACTION $Cl^{35}(d,p)Cl^{36}$.
A.M.Hoogenboom, E.Kashy and W.W.Buechner.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 1661 of 1961), Paper C5/52, p. 539-90.

Experimental $l_n = 1$ angular distributions of 36 proton groups from this reaction are compared with the Butler theory. It is shown that the peak fitting procedure using the nuclear radius as an adjustable parameter does not give satisfactory results. The experimental data indicate that the reaction energy Q should be used as an adjustable parameter, Q_{adj} in the Butler theory. With $Q_{adj} = 6.3$ MeV a reasonable fit is obtained between theory and experiment for excitation energies in Cl^{36} from 2.5 to 7.0 MeV.

19511 DISTORTED-WAVE CALCULATIONS OF THE $Li^7(d,p)$ STRIPPING REACTION. J.H.Halton and P.E.Hodgson.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 1661 of 1961), Paper C5/55, p. 593-4.

Experimental differential cross-sections for the reaction $Li^7(d,p)Li^9$ (GS) are analysed by the Butler and distorted-wave stripping theories to yield estimates of the reduced widths. The distorted-wave theory produces a better fit to the experi-ntal results and a more nearly constant θ^2 for the range 2 to 4 MeV incident deuteron energy. These values are about ten times eater than those obtained from the Butler theory.

19512 MEASUREMENTS OF PROTON POLARIZATION IN DEUTERON STRIPPING AT 15 MeV.
soya, S.Micheletti, M.J.Marrone and L.H.Reber.
therford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 1961), Paper C5/56, p. 595-6.

The angular dependence of the proton polarization was measured a number of (d,p) stripping reactions initiated by 15 MeV terons. Transitions corresponding to an angular momentum nsfer equal to zero were studied on Al^{27} and Si^{28} and corres-nding to an angular momentum transfer equal to one on C^{12}, Mg^{24} d V^{51}.

19513 ON THE EFFECT OF PROTON SPIN—ORBIT DISTORTION IN A (d,p) REACTION. R.C.Johnson.
therford Jubilee Conference, Manchester, 1961 (see Abstr. 610 of 1961), Paper C5/58, p. 599-600.

The angular distribution and polarization of the protons in the action $C^{12}(d,p)C^{13*}$ (first excited state) are calculated for a uteron energy of 6 MeV (CM) taking into account spin-dependent stortion of the proton. The proton polarization, which vanishes spin-dependent distortion is neglected, is found to be large, but e angular distribution is insensitive to the inclusion of such effects.

19514 FIRST ORDER EFFECTS OF SPIN-DEPENDENT DISTORTION IN DIRECT REACTIONS. R.C.Johnson.
therford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 1961), Paper C5/59, p. 601-2.

A first-order treatment of proton spin—orbit distortion in an) = 0 deuteron stripping reaction is given. To this approximation, e angular distribution is independent of the spin—orbit potential and e proton polarization is found to agree closely with exact cal-lations in a special case. Simple expressions for the polarization e found, which may be useful for the study of polarization effects deuteron stripping.

19515 RADIATIVE CAPTURE OF DEUTERONS IN Be^9 AND C^{12}. H.H.Knitter and H.Wäffler.
therford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 1961), Paper C8/24, p. 823-4.

Deuteron capture in Be^9 and C^{12} was observed using aseodymium and copper as (γ,n) threshold detectors. Cross-ctions of 6.5 and 0.3 μb were found for 1.3 and 1 MeV deuterons spectively.

19516 ON THE ANALYSIS OF DEUTERON STRIPPING REACTIONS. M.Nagasaki.
uovo Cimento (Italy), Vol. 21, No. 5, 716-21 (Sept. 1, 1961).

The equivalence of the Butler and Born approximations is erified for the deuteron reaction in the extrapolation method of etermining the reduced width of the captured nucleon. The elation between the extrapolation method and the method of owcock is discussed. Numerical comparison is given for the articular case of $C^{12}(d, p)\ C^{13*}$(3.09 MeV state) at $E_d = 2.89$ MeV.

19517 THE ANALYSIS OF (d, p) STRIPPING REACTIONS BY THE DISTORTED WAVE BORN APPROXIMATION.
.Buck and P.E.Hodgson.
hil. Mag. (GB), Vol. 6, 1371-84 (Nov., 1961).

The formulae giving the differential cross-section for a (d, p) tripping reaction, the polarization of the outgoing proton and the ngular correlation between it and the gamma-ray from the residual ucleus are summarized for the distorted wave Born approximation. ethods of programming this calculation for an electronic computer re described, and the results of some check calculations are given.

19518 POLARIZATION OF NUCLEI IN THE STRIPPING REACTION. V.F.Kharchenko.
krayin. fiz. Zh. (USSR), Vol. 5, No. 2, 272-3 (1960). In Ukrainian.

Discusses polarization of protons and final nuclei in (d, n) tripping reactions.

19519 CIRCULAR POLARIZATION OF GAMMA QUANTA IN THE REACTION $B^{10}(d,p\gamma)B^{11}$.
.Zimani, Ya.Érě, L.Poch and I.Sentpeteri.
h. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 709-11 (Feb., 1961). n Russian.

A 90% enriched B^{10} target was bombarded with 420 keV deuterons. Protons and γ-rays were detected in coincidence in directions 90° apart in the plane perpendicular to the incident deuterons. The circular polarization P_γ was analysed by transmission through 8 cm of magnetized iron. It was found that $P_\gamma = 37 \pm 19\%$ for the 2.14 MeV γ-ray from the first excited state of B^{11}. This has spin $\frac{1}{2}$ and the transition is M1, giving the polarization of the final nucleus $P_f = -2 P_\gamma$. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 496-7 (Aug., 1961)].

19520 MEASUREMENT OF THE NEUTRON FLUX OF THE REACTION $C^{12}(d,n)N^{13}$ BY MEANS OF THE ACTIVITY OF THE N^{13}. A.Keller.
Scientia (Chile), No. 113, 31-7 (Jan.-March, 1961). In Spanish.

The main problem of the measurement of the neutron flux of the reaction $C^{12}(d,n)N^{13}$ by means of the activity of N^{13} is the possibility of an escape of nitrogen from the target. A method of measuring possible losses of N^{13} is described, and measurements with TiC targets in an accelerator of the Cockroft—Walton type are described. Formulae to compute the neutron flux from the observed activity of N^{13} are given.

19521 NEUTRON POLARIZATION IN THE REACTION $C^{12}(d,n)N^{13}$. I.I.Levintov and I.S.Trostin.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1570-1 (June, 1961). In Russian.

The azimuthal asymmetry of neutrons from this reaction and scattered on helium was measured. The measurements were carried out on the neutron group corresponding to the formation of N^{13} in the ground state. The deuteron energy is 11.8 ± 0.8 MeV. The polarization values of neutrons emitted at various angles from the carbon target are calculated by employing the Seagrave phase-shifts for (n, He^4) scattering. (Abstr. 1736 of 1954). [English translation in: Soviet Physics—JETP (USA)].

19522 THE APPLICATION OF DISTORTED WAVE BORN APPROXIMATION CALCULATIONS TO THE ANALYSIS OF SOME (d,p) ANGULAR DISTRIBUTIONS. H.D.Scott.
Nuclear Phys. (Internat.), Vol. 27, No. 3, 490-506 (Oct., 1961).

Proton angular distributions obtained by bombarding the nuclei Na^{23}, Ni^{58} and Ni^{60} with 9 MeV deuterons were analysed. It was possible to fit the distributions with unique l-value distorted-wave curves in cases where l-value ambiguities had previously existed in the Butler analysis. The reduced widths extracted in both Butler and distorted-wave calculations for a particular l-value are compared. The relative values obtained by both methods are found to be generally in good agreement.

19523 DETERMINATION OF THE COMPOUND NUCLEUS AND STRIPPING FRACTION OF (d,p) AND (d,n) REACTIONS IN Zr^{94} AND Zr^{96}. R.Bock.
Z. Phys. (Germany), Vol. 164, No. 5, 546-57 (1961). In German.

An experiment was made which gives information on the reaction mechanism of the ($Zr^{94,96}$ + d) reactions. Total cross-sections and excitation functions up to 11.8 MeV were measured for the reactions $Zr^{94}(d,p)$, $Zr^{94}(d,n)$, $Zr^{96}(d,p)$, $Zr^{96}(d,n)$ and $Zr^{96}(d, 2n)$ by the activation method. The results are compared with cross-sections calculated according to the statistical theory of nuclear reactions. It is shown that the (d,p) reactions proceed almost completely by the stripping mechanism. The (d,n) and (d, 2n) excitation functions on the other hand are in good agreement with the predictions of the statistical theory and one can conclude that the compound-nucleus mechanism is the dominating process.

Due to Alpha-particles

19524 OPTICAL MODEL ANALYSES OF He^3 ELASTIC SCATTERING. P.E.Hodgson.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C3/9, p. 407-8.

The optical model potentials fitting the experimental data on the elastic scattering of 29 MeV He^3 by a range of nuclei are tabulated and compared. On the whole the potentials decrease with increasing target size, and the surface diffuseness parameter shows some correlation with nuclear shell structure. Calculations are made on the relative importance of different parts of the nuclear potential, and it is shown that the interior of the potential has a negligible effect on the elastic scattering.

19525 THE $^{13}C(^{3}He,\alpha\gamma)^{12}C$ REACTION.
H.D.Holmgren and E.A.Wolicki.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/26, p. 539-40.

The angular correlations between the first excited-state alpha-particles from the $C^{13}(He^3,\alpha)C^{12}$ reaction and the subsequent 4.43 MeV gamma-rays were studied as functions of the angle of emission of the gamma-rays for alpha-particles emitted at laboratory angles of 10°, 25°, 40°, 90°, and 128° at a bombarding energy of 4.50 MeV. The correlation functions are fitted with an expression of the form

$$W(\theta\gamma) = 1 + b_2 \cos 2(\theta\gamma - \theta_2) + b_4 \cos 4(\theta\gamma - \theta_4)$$

The cos 4θ term dominates the correlation function at low angles and the θ_4-phase angle remains constant, while the θ_2-phase angle behaves similar to the recoil axis at low angles.

19526 AN INVESTIGATION OF THE $C^{13}(He^3,n_0)O^{15}$ AND THE $C^{14}(He^3,n_0)O^{16}$ REACTIONS.
R.G.Johnson, L.F.Chase, Jr and F.J.Vaughn.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/54, p. 591-2.

The $C^{13}(He^3,n_0)O^{15}$ and $C^{14}(He^3,n_0)O^{16}$ reactions were investigated from about 1.6 to 3.4 MeV using a neutron time-of-flight system. The 10° yield curve for the $C^{13}(He^3,n_0)O^{15}$ reaction increased monotonically with energy. Angular distributions for this reaction, obtained at 2.6, 2.8 and 3.1 MeV, are peaked at 0° and exhibit secondary maxima near 100°. The 0°-yield curve for the $C^{14}(He^3,n_0)O^{16}$ reaction exhibits resonance structure at 2.0 and 2.8 MeV. Angular distributions for this reaction are peaked at 0° and at backward angles. The data are compared with the double stripping theory of Newns.

19527 EVIDENCE FOR DIRECT INTERACTION IN α-INDUCED REACTIONS AT LOW ENERGIES.
J.B.Garg and N.H.Gale.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/60, p. 603-4.

Several (n,γ) angular correlations from the reaction $Be^9(\alpha,n)C^{12}$ leading to the 4.43 MeV level in C^{12} were measured using a time-of-flight technique. The measurements were made at an incident α-particle energy of 5.35 MeV, and for various positions of the neutron counter. The results of these measurements show qualitative agreement with the expectation of plane wave theories of the direct interactions. It does not seem possible to estimate the exact contribution to this reaction of different processes without making calculations based on the DWBA theory of direct reactions.

19528 ANGULAR DISTRIBUTIONS OF NEUTRONS FROM THE REACTION $Li^7(\alpha,n)B^{10}$ AT 13.5 AND 13.9 MeV.
J.Kjellman, A.Nilsson and S.Schwarz.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/61, p. 605-6.

Neutron angular distributions from the reaction $Li^7(\alpha,n)B^{10}$ at 13.5 and 13.9 MeV were studied by the time-of-flight technique with α-particles from the 80 cm cyclotron at the Nobel Institute. Five neutron groups were observed corresponding to the ground state and the four lowest excited states in B^{10}. The higher α-energy gives an excitation of the compound nucleus B^{11} coinciding with a resonance in the excitation function. A method for splitting up the unresolved double-peak due to n_0 and n_1 in the forward directions is developed. The angular distributions of the groups n_0 and n_1 are presented.

19529 THE $B^{10}(\alpha,n)N^{13}$ AND $B^{10}(t,2n)C^{11}$ REACTIONS IN A NUCLEAR REACTOR. J.C.Roy and J.J.Hawton.
Canad. J. Phys., Vol. 39, No. 11, 1528-34 (Nov., 1961).

N^{13}(10 min) and C^{11}(20 min) were produced in the NRX reactor by the following reactions:

$$B^{10}(\alpha,n)N^{13} \text{ and } B^{10}(t,2n)C^{11}.$$

The alpha particles and the tritons were generated by thermal neutron capture in B^{10} and Li^6, respectively. These reactions offer a simple and rapid method of obtaining C^{11} and N^{13} in fairly high specific activities. It is estimated that activities of the order of 100 μc of N^{13} and 1 mc of C^{11} can be produced in a thermal neutron flux of 6.5×10^{13} n/cm^2 sec. Incidental to these studies are some observations on the chemical behaviour of N^{13} and C^{11} recoil atoms in a few boron compounds.

Due to other Particles and Nuclei

19530 THE $^{7}Li(t,\alpha)^{6}He$ REACTION.
H.D.Holmgren and L.M.Cameron.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 1661 of 1961), Paper C5/25, p. 537-8.

The differential cross-sections for the ground-state and first two excited-state alpha-particle groups from the $Li^7(t,\alpha)He^6$ react were measured as functions of the angle of emission and the bombarding energy in the region from 1 to 2 MeV. All groups exhibit broad resonance ($\Gamma \cong 500$ keV) in the region of 1.8 MeV. Forward maxima appear in the angular distributions of the two highest energy groups at the higher bombarding energies. The backward maxima, which are present at the lowest bombarding energies, ar further pronounced at the higher energies. The total cross-sectio for the ground-state and first excited-state groups at 1.95 MeV ar 19 and 25 mbn respectively.

19531 SINGLE-NUCLEON TRANSFER REACTIONS INDUCED BY 28 MeV N^{14} IONS.
E.Newman, K.S.Toth, M.L.Halbert and A.Zucker.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 1661 of 1961), Paper C5/30, p. 547-8.

The following transfer reactions induced by 28 MeV N^{14} ions investigated: (1) $N^{14}(N^{14},N^{13})N^{15}$, (2) $B^{10}(N^{14},N^{13})B^{11}$, (3) $B^{10}(N^{14},O^{15})$ (4) $B^{10}(N^{14},C^{13})C^{11}$, (5) $B^{11}(N^{14},C^{13})C^{12}$, (6) $Mg^{24}(N^{14},N^{13})Mg^{25}$. For reactions (1) to (4), angular distributions were obtained for the outgoing particles that resulted from transfers in which both residual nuclei were left in their ground states. For Rutherford orbits, the parameter r_0 was found to be 2.2×10^{-13} cm. Reactions (1) and (2) were also investigated as a function of bombarding energy. It was found that as the incident energy of N^{14} was lowered, the ground-state transfer cross-section decreased, while the cross-section fo transfers to excited states increased.

19532 NUCLEAR REACTIONS PRODUCED BY 2 MeV Li^6 ON Be^9. M.Coste, C.Lemeille, N.Saunier and L.Marquez.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/48, p. 583-4.

Measurements with scintillators showed that the most intense gamma-rays are those from the first excited state of Li^7 and B^{10}. Measurements with plates and junctions showed several groups of alpha-particles from the double stripping reaction $Be^9(Li^6,\alpha)B^{11}$. Coincidences between the junction spectra and the 479 keV gamma-ray indicate that the double stripping reaction leading to a higher state is the primary reaction followed by break up of B^{11} into $\alpha + Li^7$ or $N + B^{10}$.

19533 STUDIES ON THE $Li^6(Li^6,d)B^{10}$ AND $Li^7(Li^6,t)B^{10}$ REACTIONS WITH 6 MeV LITHIUM IONS.
D.A.Bromley, K.Nagatani, L.C.Northcliffe, R.Ollerhead and A.R.Quinton.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/57, p. 597-8.

The reactions $Li^6(Li^6,d)B^{10}$ and $Li^7(Li^6,t)B^{10}$ were examined using the 1 MeV/nucleon lithium beam from the Yale Heavy Iron Linear Accelerator and a $(dE/dx) \times E$ particle identification system. Deuteron and triton groups to the ground and first three excited states of B^{10} were detected, as found by Morrison, using 2 MeV lithium ions. Both reactions lead to the 1.74 MeV 0^+, T = 1 state in B^{10} and are very strongly inhibited, providing strong support for a direct interaction mechanism.

19534 THE REACTION $C^{12}(C^{12},\alpha)Ne^{20}$.
A.J.P.L.Policarpo, W.R.Phillips and J.C.Lisle.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C5/63, p. 607-8.

Differential cross-sections for the reaction $C^{12}(C^{12},\alpha)Ne^{20}$ leading to the first two levels in Ne^{20} were measured at a bombardi energy of 12.5 MeV. The total cross-sections are 2.2 ± 0.4 mb and 7 ± 1.4 mb to the ground and first excited states respectively. The ground state group's angular distribution shows features which can be reproduced by considering the reaction to proceed via a stripping mechanism.

19535 ANGULAR MOMENTUM EFFECTS IN NUCLEAR EVAPORATION. M.L.Halbert and C.E.Hunting.
therford Jubilee Conference, Manchester, 1961 (see Abstr. 16610
1961), Paper C8/3, p. 773-4.

Angular distributions were measured for protons from reactions N^{14} (at 21.4 and 27.4 MeV) on F^{19} and for alphas from N^{14} (at 2 MeV) on O^{16}. Forward and backward peaking was observed, h approximate symmetry about 90° (cm). From the proton data, parameter σ, appearing in the expression

$$(2j + 1)\exp-[j(j + 1)/2\sigma^2]$$

the spin dependence of the level density, is about 3 for P^{32}. is implies a moment of inertia approximately equal to the rigid-dy value. The alphas were more anistropic, and the simplified alysis applied to the protons was inadequate. Least-square fits re obtained by use of Legendre polynomials.

19536 NEUTRON YIELD FOR THE REACTION BETWEEN TRITONS AND FLUORINE AND ALUMINIUM NUCLEI.
.K.Valter, P.I.Vatset, L.Ya.Kolesnikov, S.G.Tonapetyan,
.K.Chernyavskii and A.I.Shpetnyi.
h. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1237-43 (May, 1961).
Russian.

The neutron yield from the F^{19}(t,n) and Al^{27}(t,n) reactions was tudied for triton energies up to 2.4 MeV. The dependence of the ifferential cross-section on the triton energy is derived for eutron emission at an angle of 0°. The position of a set of excited evels in the intermediate nucleus Ne^{22} is determined from the esonance of the differential cross-section for the F(t,n) reaction. he symmetry of the neutron angular distribution in the c.m.s. elative to 90° at five triton energies indicates that, up to 2.1 MeV, he F^{19}(t,n) reaction proceeds mainly via the formation of an intermediate nucleus. The total cross-sections of the F^{19}(t,n) reaction re determined for a number of energies. [English translation in: oviet Physics—JETP (USA)].

19537 NEUTRONS FROM THE C^{12} (t, n) REACTION. P.I.Vatset, L.Ya.Kolesnikov and S.G.Tonapetyan.
h. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1257-60 (May, 1961).
Russian.

The neutron yield at an angle of 0° from the C^{12} (t,n) reaction was investigated for triton energies between 0.35 and 2.4 MeV. even resonances were observed which correspond to excited tates of the N^{15} nucleus with the following energies: 15.887, 5.955, 16.066, 16.206, 16.326, 16.430, 16.582, 16.67 and 16.77 MeV. The neutron angular distributions were measured for five different riton bombarding energies. For triton energies exceeding 1 MeV he angular distributions were anisotropic; above 1.5 MeV triton energies the neutrons were emitted predominantly in the backward direction. The total cross-section for the reaction was determined from he angular distributions and found to be 4.8 ± 0.2 mbn for E_t = 0.652 MeV increasing to 298.6 ± 19.7 mbn at E_t = 2.017 MeV. English translation in: Soviet Physics—JETP (USA)].

19538 INVESTIGATION OF THE V^{51}(C^{12},2n)Cu^{61} REACTION. A.S.Karamyan and A.A.Pleve.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1541-2 (June, 1961).
In Russian.

Previously published results may be inaccurate due to the presence of Mn^{56} among the reaction products. The emissions from this isotope are similar to those from Cu^{61}. A quantitative treatment of this problem requires further and more detailed investigation. [English translation in: Soviet Physics—JETP (USA)].

Nuclear Fission

19539 SOME NEW INSIGHT INTO THE THEORY OF NUCLEAR FISSION. A.van der Woude.
Ned. Tijdschrift Natuurkde (Netherlands), Vol. 26, No. 10, 317-22
(Oct., 1960). In Dutch.

Reviews the present position of fission theory (11 references). It is claimed that a discrepancy between the plots of log T against Z^2/A for even—even and even—odd nuclei can be explained by taking account of the fact that an even—even nucleus can remain in a state of zero total spin during deformation. If this correction is combined with one due to Johansson (Abstr. 12697 of 1959), it is found that the spread among even—even nuclei is reduced, and that the even—even and even—odd data are reasonably well expressed by the same plot of log T against Z^2/A. H.N.V.Temperley

19540 SPONTANEOUS FISSION OF Am^{241}. V.A.Druin, V.L.Mikheev and N.K.Skobelev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1261-2 (May, 1961).
In Russian.

A gas scintillation counter filled with xenon was used to measure the spontaneous fission half-life of Am^{241}. A value of (2.3 ± 0.8) × 10^{14} years was found, in contrast to the value 1.4 × 10^{13} years accepted hitherto. [English translation in: Soviet Physics—JETP (USA)].

19541 SPONTANEOUS FISSION PERIODS OF Np^{237}, Pu^{238} AND Pu^{242}.
V.A.Druin, V.P.Perelygin and G.I.Khlebnikov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1296-8 (May, 1961).
In Russian.

An attempt was made to determine the true spontaneous fission period of Np^{237} by employing nuclear photographic emulsions. Prior to development the photographic plates were treated with potassium ferrocyanide for the purpose of removing background α-particle tracks. Reliability of the method was checked by measuring the spontaneous fission periods of Pu^{238} and Pu^{242}, which were independently determined by means of a proportional counter. The plutonium results obtained by the various methods were found to be the same and to agree with other available data. Only three fragment tracks were detected in the Np^{237} photographic measurements. A lower limit of 10^{18} years for the half-life was derived, compared with the accepted value of 4 × 10^{16} years. [English translation in: Soviet Physics—JETP (USA)].

19542 A STUDY OF U^{235} FISSION WITH EMISSION OF A LIGHT FRAGMENT.
J.Catalá, V.Domingo, J.Casanova, F.Senent and A.Lleó.
An. Real Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 1-2, 19-28
(Jan.-Feb., 1960). In Spanish.

A search for light fragments from U^{235} fission was made by an emulsion technique, using the thermal column of the BR-1 reactor for neutron irradiation. 300 events were found by scanning and analysed with regard to range, angular distribution, mass and energy. Only ranges over 30μ were considered, in order to discriminate against the 22μ uranium α-particles. The energy distribution shows a peak at about 15 MeV (110μ range); the upper range limit is 460μ. The angular peak is at 83° (between the light fragments and the heavy fragment of longest range). The average mass is about 4, which strongly suggests an α-particle; the error in mass is, however, rather large. The mean value of the total energy of all 3 fragments is 162 MeV, which is somewhat lower than the theoretical value. B.Cimbleris

19543 TWO TRIPLE FISSION EVENTS IN THERMAL NEUTRON BOMBARDMENT OF U^{235}.
J.Catalá, J.Casanova and V.Domingo.
An. Real Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 1-2, 29-34
(Jan.-Feb., 1960). In Spanish.

Nuclear emulsions charged with enriched uranium were irradiated in the thermal column of the BR-1 reactor (Mol); two photographs of triple fission are shown, in which the third track cannot be an α-particle; the mass and energy balances also exclude the hypothesis of an elastic scattering with a nucleus in the emulsion. The masses were respectively 12 ± 2 and 11 ± 2 a.m.u., which are lower than any found previously; the energies were 35 ± 7 and 40 ± 10 MeV. B.Cimbleris

19544 ANISOTROPY OF FRAGMENTS $I_{0°}/I_{90°}$ IN THE FISSION OF U^{233} BY NEUTRONS WITH ENERGIES OF 100-1000 keV. V.A.Shigin.
Dokl. Akad. Nauk SSSR, Vol. 140, No. 2, 351-3 (Sept. 11, 1961).
In Russian.

An experimental study of the variation with neutron energy of the ratio of the number of fission fragments emitted in the direction of the incident neutron beam to the number emitted at right angles shows that it increases from a value of 1.02 ± 0.035 at 85 keV to an effectively constant value of 1.07-1.08 above 160 keV. [English translation in: Soviet Physics—Doklady (USA)]. J.E.Gore

19545 THE AVERAGE NUMBER OF NEUTRONS $\bar{\nu}$ FROM THE FISSION OF U^{238} BY 14 MeV NEUTRONS.
N.N.Flerov and E A.Tamanov.
Atomnaya Energiya (USSR), Vol. 5, 654 (1958). In Russian.
English translation in: Reactor Sci. Technol. (GB), Vol. 11, No. 2-4, 171-3 (Feb., 1960).

The average was determined by observing the number of two-fold coincidences between the neutrons emitted during a single fission event. At the same time the number of neutrons emitted as a result of the (n,2n) reaction with lead was measured, i.e. the average number of secondary neutrons released in U^{238} fission was determined relative to the number of neutrons emitted in the Pb(n,2n) reaction. After applying appropriate corrections to the measured values, the value of $\bar{\nu} = 4.45 \pm 0.35$ which is in excellent agreement with results obtained by other methods. B.Brown

19546 THE 14.6 MeV U^{238} FISSION CROSS-SECTION. N.N.Flerov, A.A.Berezin and I.E.Chelnokov.
Atomnaya Energiya (USSR), Vol. 5, 657 (1958). In Russian.
English translation in: Reactor Sci. Technol.(GB), Vol. 11, No. 2-4, 173 (Feb., 1960).

The 14.6 MeV U^{238} fission cross-section was measured using a thin walled ionization chamber. Details of the method are given and after applying corrections for background, etc., the cross-section finally obtained was $\sigma_f = (1.13 \pm 0.05)$ barn. This is in good agreement with other unpublished work. B.Brown

19547 14.6 MeV FISSION CROSS-SECTIONS OF U^{235} AND Th^{232}. A.A.Berezin, G.A.Stoliarov, Yu.V.Nikol'skii and I.E.Chelnokov.
Atomnaya Energiya (USSR), Vol. 5, 659, (1958). In Russian.
English translation in: Reactor Sci. Technol. (GB), Vol. 11, No. 2-4, 175 (Feb., 1960).

The fission cross-section of U^{235} was measured relative to the fission cross-section of U^{238} for neutrons of the same energy. Details of the method used are given and a value of $\sigma_f^{235} = (2.30 \pm 0.15)$ barn was obtained for the 14.6 MeV fission cross-section of U^{235}. That of Th^{232} was measured by a different method and the value was found to be $\sigma_f^{232} = (0.37 \pm 0.02)$ barn. These values are in good agreement with other reported results. B.Brown

19548 FISSIONABILITY OF NUCLEI BY HIGH-ENERGY PROTONS. N.A.Perfilov.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 871-3 (Sept., 1961). In Russian.

Experimental data on fission of nuclei induced by high-energy protons are analysed and the relation between the limiting value of the fission cross-section σ_f and the parameter Z^2/A is established. [English translation in: Soviet Physics—JETP (USA)].

19549 OBSERVATION OF THE TRACKS OF FISSION FRAGMENTS IN MOLYBDENITE.
K.Izui and F.E.Fujita.
J. Phys. Soc. Japan, Vol. 16, No. 9, 1779 (Sept., 1961).

Fission fragment tracks in molybdenite, produced by exposing a uranium film coated with molybdenite to the neutrons from a reactor, were observed with an electron microscope. Thermal spike effects of the fission fragments were clearly observed and the structure of the thermal spike region is attributed to non-uniformity in solidification of the molten material in the spike region. B.Brown

19550 THE DEFORMATION OF FISSION FRAGMENTS. W.Brunner and H.Paul.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 11, 667-70 (1960). In German.

Proposes a semi-empirical method for the calculation of deformation energies of fission fragments as a function of their neutron number. S.J.St-Lorant

19551 DEPENDENCE OF THE ANGULAR DISTRIBUTION OF FISSION FRAGMENTS ON THE TARGET NUCLEAR SPIN. V.M.Strutinski.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 348-51 (Oct., 1961).

Angular distribution of fission fragments is calculated for small anisotropy. The analytical expression obtained takes into account the dependence of the fission and neutron widths on nuclear angular momentum. The theoretical data are compared with experiment.

19552 DEPENDENCE OF THE ANGULAR DISTRIBUTION OF FISSION FRAGMENTS ON THE SPIN OF THE TARGET NUCLEUS. V.M.Strutinskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 933-5 (March, 1961). In Russian.

A simple analytic expression for the angular distribution of fission fragments is derived in the case of small anisotropy. The effect of the initial nuclear spin is discussed. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 3, 652-3 (Sept., 1961

19553 ANISOTROPY IN THE FISSION OF BISMUTH AND URANIUM BY 660 MeV PROTONS.
A.I.Obukhov and N.A.Perfilov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1250-2 (May, 1961). In Russian.

The angular distribution of fission fragments was studied by means of nuclear emulsions. The transverse anisotropy coefficients were found to be 0.02 ± 0.06 and 0.04 ± 0.07 for bismuth and uranium respectively. [English translation in: Soviet Physics—JETP (USA)].

19554 THE UPPER LIMIT OF THE ENERGY SPECTRUM OF LIGHT FRAGMENTS EMITTED IN THERMAL NEUTRON FISSION OF U^{235}.
J.Catalá, J.Casanova, V.Domingo, F.Senent, E.Villar and R.Font.
An. Real Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 1-2, 39-42 (Jan.-Feb., 1960). In Spanish.

The upper energy limit of 26 MeV assigned by other workers t the light fragment in U^{235} fission was exceeded in a few tracks; this raises a question as to the nature of the particle responsible for such tracks. A calculation of the potential energy of an α-particle in the Coulomb field of the heavy fragments gave 34.4 MeV, in agreement with the highest experimental value obtaine in this study, 35.5 MeV. B.Cimbleri

Thermonuclear Reactions

19555 FUSION CROSS-SECTION MEASUREMENTS WITH DEUTERONS OF LOW ENERGY.
A.von Engel and C.C.Goodyear.
Proc. Roy. Soc. A (GB), Vol. 264, 445-57 (Dec. 5, 1961).

A knowledge of the energy dependence of the cross-section for collisions between two deutrons, leading to a triton and a proton, is of interest both to nuclear theory and to calculations of the rate of thermonuclear reactions. Until now reliable values were only available down to about 13 keV and thus the contributions by the large number of slower particles in a distribution could not be assessed. The purpose of the work was to extend this range to lower energies which involves the measurement of very small cros sections. The method of measuring the fusion cross-sections mad use of an intense ion beam and of the observation of the fast proton from the reaction normal to the beam over an angle 2π. The beam intensity was raised by avoiding an ion focusing system and using a simple extraction electrode with equal gas pressure in the ion source and gas target. Observation over a large angle was achieve by depositing a scintillation detector on a light guide which surroun ed the target chamber. From calorimetric measurements of the be current and measurements of the counting rate, relative cross-sections were obtained for deuteron energies up to 15 keV where absolute cross-sections are well known. In this way absolute values of the cross-section were found from 15 keV down to 4 keV, where a value of 9×10^{-33} cm^2 was measured. Although the results are consistent with Gamow's relation, the cross-section in the lower energy range is slightly larger than expected.

NUCLEAR POWER STUDIES

19556 STABILITY IN THE LARGE OF HETEROGENEOUS POWER REACTORS. H.B.Smets.

ll. Acad. Roy. Belgique Cl. Sci., Vol. 47, No. 5, 382-405 (1961).

Liapounoff's second method is used for the determination of the onditions of stability in the large of nuclear power reactors. The oblem of a double lag power reactivity feedback is analysed in tail and it is shown that stability in the small implies stability in e large in most cases. The stability properties of reactors with positive and a negative power coefficient of reactivity, of boiling ater reactors and of reactors with xenon build-up are considered the examples.

19557 TOPOLOGY OF LINEAR NEUTRON KINETICS. L.G.Kemeny.

ature (GB), Vol. 191, 263-4 (July 15, 1961).

The use of an integral equation for the formulation of the eutron kinetics of a nuclear reactor has definite advantages over e usual simultaneous differential equations approach. In partic- lar, the logical relationship to the topology of a chain reaction ppears at once, as well as the structural relationship to the robability generating functions method. By using an integral quation due to Schmid, the author has carried out a series of rogrammes on a digital computer by calculating the transfer unctions of step, pulse, ramp, sine and arbitrary time-responses f fixed, circulating fuel and boiling-water reactors. [Only a few urves for the boiling water reactor appear in this letter, and no etails are given]. B.Cimbleris

RAPID THERMONUCLEAR REACTIONS IN SUPERNOVA XPLOSIONS. See Abstr. 18122

19558 SPATIAL DISTRIBUTION OF RESONANCE ABSORPTION IN FUEL ELEMENTS. M.Wagner

Nuclear Sci. Engng (USA), Vol. 8, No. 3, 278-81 (Sept., 1960).

An analytical approach, in which scattering in the absorber and Doppler broadening of resonances is ignored, leads to an asymptotic expression, valid throughout the absorber except for a thin surface region, in which, for any particular geometry, the absorption distribution is represented by a universal function of the spatial coordinates. The results agree well both with more exact Monte Carlo calculations and with experimental data. J.E.Gore

19559 THERMAL UTILIZATION FACTOR IN WATER— GRAPHITE MODERATED LATTICE.

A.Kuszell and J.Mika.

Nukleonika (Poland), Vol. 5, No. 11, 743-54 (1960).

Discusses and compares one- and two-group calculation methods of the thermal utilization factor in a heterogeneous reactor with two moderators. Gives a modification of the standard two-group method, based on the assumption of non-zero neutron current at the boundary of the cell.

19560 NATURAL URANIUM LIGHT WATER LATTICES. F.E.Prieto and G.S. de Oyarzabal.

Rev. Mexicana Fis., Vol. 9, No. 4, 213-54 (1960). In Spanish.

A first-order parametric study was made of natural uranium light water cylindrical lattices with a hexagonal cell. The following were calculated and plotted: thermal utilization factor as a function of the radius of the cell, r_0; resonance escape probability; fast fission factor as a function of water/uranium volume ratio, r_V (by the Tavernier formula); the multiplication factor, k_∞ (by the four-factor formula), as a function of the radius, r_0, and as a function of the radius of the equivalent cell; the buckling as a function of r_V; critical mass and subcritical multiplication; reflector savings and the pitch of the lattice. The calculated curves are in reasonable agreement with experimental points reported in the literature. B.Cimbleris

19561 A MULTIGROUP CALCULATION CARRIED OUT ON "STRELA" FOR A POWER STATION REACTOR.

V.A.Chuyanov.

Atomnaya Energiya (USSR), Vol. 7, 64 (1959). In Russian. English translation in: Reactor Sci. (GB), Vol. 12, No. 3, 125-7 (June, 1960).

Marchuk's [J. nuclear Energy (GB), Vol. 3, 238 (1956)], multigroup method was used to calculate the effective multiplication factor and neutron flux distribution in a homogeneous power reactor model near criticality. A programme for the "Strela" computer was used to solve the problem by an iterative process, and the number of iterations required to give an accurate value of k_{eff} and the effect of the number of neutron groups used were examined. J.E.Gore

19562 FLUX ADJOINTS FOR SLOWING DOWN PROBLEM IN INFINITE MEDIA. G.Rowlands.

Reactor Sci. (GB), Vol. 13, No. 1-2, 36-7 (Oct., 1961).

Following a previous article concerning the expression of the neutron flux, $\phi(u)$, as a function of lethargy [Reactor Sci. (GB), Vol. 11, No. 2-4, 150-8 (Feb., 1960)], a trial function is found for the flux adjoint, $\phi^+(u)$, by solving the corresponding integral equation with Laplace transform techniques. R.A.Coombe

19563 AN APPROXIMATE METHOD OF HOMOGENIZING A HETEROGENEOUS REACTOR. V.V.Smelov.

Atomnaya Energiya (USSR), Vol. 6, 546 (1959). In Russian. English translation in: Reactor Sci. Technol. (GB), Vol. 13, No. 1-2, 43-50 (Oct., 1960).

It is pointed out that the mathematical procedure for homogenizing a heterogeneous reactor can be prescribed in a variety of ways, not necessarily all leading to the same parameters. Thus the constants of a homogenized reactor cannot be uniquely defined. The general principles of homogenization are considered, using k_{eff} as a functional, and it is demonstrated that the use of effective cross-sections for capture and fission derived by averaging over the neutron spectrum in an infinite lattice leads to an error in k_{eff} proportional to the Laplacian. In particular it is possible to determine a unique diffusion coefficient, even for a strictly defined direction. Any attempt to increase the accuracy results in the effective parameters ceasing to have universal applicability, and they become characteristic of the form and dimensions of the reactor. Formulae are presented for plane, cylindrical and spherical geometries which specify the diffusion coefficient in finite reactors as a function of direction.

19564 THE EFFECT OF A CYLINDRICAL CHANNEL ON NEUTRON DIFFUSION. N.I.Laletin.

Atomnaya Energiya (USSR), Vol. 7, 18 (1959). In Russian. English translation in: Reactor Sci. Technol. (GB), Vol. 13, No. 1-2, 57-64 (Oct., 1960).

Voids in the core of a reactor affect the neutron leakage significantly and it is important to allow for this leakage when calculating a critical mass. It is also often of interest to know how empty channels affect the manner in which neutrons diffuse out of the core. The effect of a single hollow cylindrical channel is considered here. Expressions are derived for the neutron leakage along a channel through the centre of the reactor and for the additional losses in the vicinity of the channel arising from the presence of the channel. The way the form of the flux distribution along the channel affects the applicability of diffusion formulae is considered.

19565 A MEASUREMENT OF THE HIGH-ENERGY NEUTRON SPECTRUM IN THE REACTOR BR-5 USING A ^{3}He IONIZATION CHAMBER. A.I.Abramov and M.G.Iutkin.

Atomnaya Energiya (USSR), Vol. 6, 575 (1959). In Russian. English translation in: Reactor Sci. (GB), Vol. 13, No. 1-2, 76-7 (Oct., 1960).

A small spherical ionization chamber filled with a mixture of H^3 and argon was used. The measurements were made in the nickel shield of the reactor. The range of the measurements was from 125 keV to about 1.3 MeV. The spectrum measured in the shield is somewhat softer than was expected from a nine group calculation. M.Salmon

19566 PILE OSCILLATOR MEASUREMENTS OF HIGHLY IRRADIATED PLUTONIUM. W.A.Cooper and H.Rose.

Reactor Sci. Technol. (GB), Vol. 13, No. 1-2, 6-13 (Oct., 1960).

Samples of plutonium alloyed with aluminium were irradiated up to a maximum neutron dosage of 1.7 n/kb in the NRX reactor at Chalk River. At this irradiation over 80% of the original Pu^{239} is destroyed. The resultant changes in cross-section were measured with the pile oscillator in Gleep. The results are in agreement with theoretical predictions based upon present world nuclear data for plutonium isotopes as compiled by Westcott (1958). This agreement gives added confidence in the ability to predict reactivity changes due to plutonium formation or destruction in power reactors.

19567 MEASUREMENTS ON A SUBCRITICAL ASSEMBLY OF NATURAL URANIUM AND LIGHT WATER.
M.A.Vigón and C.E.Granados.
An. Real Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 9-10, 249-56 (Sept.-Oct., 1960). In Spanish.

A subcritical assembly of 258 natural uranium rods in water with a 3.6 cm hexagonal pitch was pulsed by a 2 MV Van de Graaff accelerator, from a Li^7 target 15 cm below the bottom of the tank. The 15 cm water reflector was substituted by empty metal boxes for the non-reflected case. The results were obtained through the activation of manganese foils (13.5 mm diameter, 0.2 mm thick). The non-reflected $\alpha (= 2.405/R)$ was found as 0.0679 ± 0.0001 cm^{-1}. The reflected $\alpha = 0.0542 \pm 0.0001$ cm^{-1} and reflector savings $\delta = R' - R = 9.0 \pm 0.1$ cm. The non-reflected buckling is $B^2 = 0.95 \pm 1.08 \times 10^{-4}$ cm^{-2}. In order to study the fine structure of the neutron flux, perforated rods with 0.4 cm diameter transverse holes with Mn foils were used. Thus a thermal utilization factor $f = 0.886 \pm 0.004$ was obtained, in agreement with the calculated value (diffusion approximation). B.Cimbleris

19568 A COOLING PROBLEM OF PEBBLE-BED NUCLEAR REACTORS. L.S.Dzung.
Internat. J. Heat Mass Transfer (GB), Vol. 1, No. 2-3, 236-41 (Aug., 1960).

The fundamental equations for the steady-state flow of a gas through a porous medium with prescribed heat source are derived. Application of these equations enable the pressure drop and the flow distribution of a gaseous coolant through a pebble-bed type nuclear reactor to be calculated. One exact solution is given. The maximum gas temperature is found to be very much higher than the mixed mean value.

19569 ANGULAR DISTRIBUTION OF NEUTRONS SCATTERED FROM AN EXPERIMENTAL CHANNEL OF A REACTOR. T.Rzeszot.
Nukleonika (Poland), Vol. 5, No. 4, 191-4 (1960). In Polish.

The neutron flux at the exit of a horizontal channel of the "EWA" reactor was measured as a function of angle between the axes of th channel and of the BF_3 counter, for two power levels of the reactor 50 and 200 kW. The work is concerned with the setting up of safet measures and with the design of radiation shields. S.Swierszczews

19570 KRYPTON EVOLUTION FROM METALLIC URANIUM. F.J.Norton and C.W.Tucker, Jr.
J. nuclear Materials (Internat.), Vol. 2, No. 4, 350-2 (Dec., 1960).

Krypton ions were accelerated into uranium foil at 40 kV. The rate and temperature of release of the krypton gas was studied by the mass spectrometer. Evolution begins below 250°C and shows several peak rates. The temperature for release in this case is much lower than found in other work on fission gases formed in situ.

19571 CERENKOV COUNTER FOR FUEL-BURST DETECTION.
Nucleonics (USA), Vol. 19, No. 9, 88 (Sept., 1961).

Core outlet water from a nuclear reactor can be monitored for Cherenkov radiation emitted by β-particles from short-lived fissio products. This makes a sensitive detector of faults in fuel element R.D.Smit

19572 γ-ENERGY RELEASE BY THERMAL NEUTRONS FRO THE PRODUCTS OF U^{235} FISSION IN THE CASE OF TH PERIODIC OPERATION OF A NUCLEAR REACTOR. T.Roshesku.
Rev. de Physique (Roumania), Vol. 5, No. 3-4, 393-404 (1960). In Russian.

Calculations are performed for reactor-operating times of 6 an 12 hours, with a repetition period of 24 hours, for 1, 10 and 100 cycles. The results are subdivided into γ-energy groups using Moteff's classification (Abstr. 8218 of 1955), and comparison is made with Perkins and King's calculations (Abstr. 13301 of 1960), for continuous reactor operation. J.E.Gore

ATOMIC AND MOLECULAR PHYSICS

19573 A NOTE ON SOME PROPERTIES OF HAMILTONIANS INVOLVING SPIN MATRICES FOR HALF-INTEGRAL VALUES OF I. G.M.Volkoff.
Canad. J. Phys., Vol. 39, No. 8, 1226-32 (Aug., 1961).

Discusses spin Hamiltonians occurring in problems of nuclear magnetic and quadrupole resonance.

19574 SPIN–ORBIT COUPLING CONSTANT AND $\langle r^{-3} \rangle$ IN TRANSURANIC IONS. M.E.Foglio and M.H.L.Pryce.
Molecular Phys. (GB), Vol. 4, No. 4, 287-90 (July, 1961).

The spin–orbit coupling parameter ζ, the quantum average $\langle r^{-3} \rangle$, and binding energy $-E$ for atomic number $Z = 92, 94, 96$ and net ionic charge approximately 1 and 5, are calculated for the 5f electrons. The potential assumed in the one-electron wavefunction calculation is that given by the Thomas–Fermi model of a positive ion. It is shown that the ratio $\zeta/\langle r^{-3} \rangle$ is fairly insensitive to changes in the surroundings of the ion, and can be used for estimating one of the parameters with the experimental value of the other. The 5g electrons are shown to be effectively free in the considered range of Z and n. The behaviour of the wavefunction as a function of n and Z is discussed.

19575 ELECTRON TERMS IN THE FIELD OF TWO DIFFERENT COULOMB CENTRES.
S.S.Gershtein and V.D.Krivchenkov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1491-1502 (May, 1961). In Russian.

It is demonstrated that the Neuman–Wigner theorem on the impossibility of intersection of terms of the same symmetry is not valid for electrons in the field of two Coulomb centres. Terms for large and small distances between the nuclei are compared for the case when the nuclear charges are different. It is shown that there are term intersections which are important for charge-exchange processes during collisions between hydrogen atoms and nuclei. [English translation in: Soviet Physics–JETP (USA)].

REARRANGEMENT COLLISIONS IN THE BORN APPROXIMATION. See Abstr. 19128

19576 ACCOUNT OF THE NUCLEAR COULOMB FIELD IN THE INTERACTION BETWEEN ELECTRONS AND AN ELECTROMAGNETIC FIELD. V.G.Gorshkov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1411-21 (Nov., 1960). In Russian.

Convenient expressions for practical calculations are derived for the matrix elements of the interaction between electrons and an electromagnetic field near the nucleus. The Coulomb field is taken into account with an accuracy up to terms proportional to $(\alpha Z)^2$. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 983-9 (May, 1961)].

ATOMS

19577 ELECTRON POLARIZABILITY AND DIAMAGNETIC SUSCEPTIBILITY OF NEUTRAL ATOMS IN THE THOMAS–FERMI MODEL. T.Titts [T.Tietz].
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1699-704 (June, 1961) In Russian.

The Latter potential (Abstr. 8169 of 1955) is employed to calculate the following quantities for a free neutral atom: the field of the atomic nucleus due to variation of the density; the total induced quadrupole magnetic moment and also the change in the electric field gradient near the nucleus due to an external charge. The values obtained are finite and differ from those which the usual statistical theory of the atom yields. The diamagnetic susceptibilit toms in the Thomas—Fermi model is derived for the effective er—Byatt charge distribution. [English translation in: Soviet sics—JETP (USA)].

9578 ON THE FORMATION OF ELECTRON SHELLS IN THE PERIODIC SYSTEM OF THE ELEMENTS. P.Gombás.

a phys. Hungar., Vol. 12, No. 4, 329-31 (1960). In German.

A concise derivation of the Thomas—Fermi atom from the ır—Sommerfeld quantum conditions. Some controversial tures of the original derivation are avoided in the present treat- ıt. T.Erber

19579 THEORY OF THE ELECTRONIC STRUCTURE OF THE Au ATOM. R.Gáspár.

a. phys. Hungar., Vol. 12, No. 4, 335-49 (1960). In German.

A detailed treatment of the electronic structure of Au on the is of the "universal potential" method (Abstr. 9525 of 1954). luded are six tables summarizing quantitative information on the ve-functions and contributions to the diamagnetic susceptibility. T.Erber

THE INFLUENCE OF TERMS WITH HIGH QUANTUM MBERS ON THE CALCULATION OF PARTITION FUNCTIONS D OF THE POPULATION OF [ATOMIC] LEVELS.

Abstr. 18115

19580 ON THE SEQUENCE OF QUANTUM STATES IN ATOMS. A.Kónya.

ta phys. Hungar., Vol. 13, No. 2, 219-31 (1961). In German.

Using the statistical theory of atoms, the mean value of the are of the angular momentum and its component in an axial ection is calculated as a function of atomic number. The values nd are in good agreement with those with quantum numbers nl, in wave-mechanical theory. T.E.Peacock

19581 ELECTRON DENSITY IN IODINE USING THE STATISTICAL MODEL OF THE ATOM. Z.Füzessy.

ta phys. Hungar., Vol. 13, No. 2, 211-18 (1961). In German.

The electron density of the iodine atom is calculated using the tistical model. The density for the outer regions of the atom is nd to be in good agreement with that obtained from the best wave- chanical calculations. T.E.Peacock

ENERGY LEVELS OF THE BOUNDED HYDROGEN ATOM BY E BOUNDARY PERTURBATION METHOD. See Abstr. 18278

19582 GAUNT FACTORS FOR FREE—FREE TRANSITIONS IN HYDROGEN. M.Rudkjøbing.

em. Soc. Roy. Sci. Liege (Belgium), Sér. cinquième, Vol. III, 4-30 (1960).

The intermediate case between the two limiting approximations r high and low temperature is considered, for such a range of den- ties as is encountered in stellar models. G.A.Chisnall

19583 MEASUREMENT OF THE LAMB SHIFT OF THE $3\,^2S_{1/2}$ STATE RELATIVE TO THE $3\,^2P_{1/2}$ STATE OF HE HYDROGEN ATOM. H.Kleinpoppen.

Phys. (Germany), Vol. 164, No. 2, 174-89 (1961). In German.

The $3\,^2S_{1/2}$-$3\,^2P_{1/2}$ Lamb shift in hydrogen was measured as 13.6 ± 5.7 Mc/s by an atomic beam method. Excitation to the $^2P_{1/2}$ state was accomplished by irradiation with the Lyman L_β ne of hydrogen (1026A). Simultaneously an electric dipole ansition between $3\,^2P_{1/2}$ and $3\,^2S_{1/2}$ was induced, and its occurrence served through the decrease of the relative number of hydrogen toms in the metastable $2\,^2S_{1/2}$ state which was populated from the ecay of the $3\,^2P_{1/2}$ state. Detection of the metastable $2\,^2S_{1/2}$ hydro- en atoms was achieved by means of the Lamb—Retherford echnique. P.M.Parker

19584 MATRIX ELEMENTS FOR THE 4f ELECTRONIC CONFIGURATION. III. THE EIGENSTATES OF THE o^{3+} ION. S.Hüfner.

Phys. (Germany), Vol. 164, No. 4, 456-62 (1961). In German.

For Pt II, see Abstr. 17253 of 1961. The eigenstates and the factors in the term scheme of the free Ho^{3+} ion are calculated. he theoretical values agree with experiment within the limits f error. S.J.St-Lorant

19585 THE ATOMIC g VALUES OF SOME RARE-EARTH ATOMS. K.F.Smith and I.J.Spalding.

roc. Roy. Soc. A (GB), Vol. 265, No. 1320, 133-40 (Dec., 1961).

The atomic g_J factors of several low-lying states in the ground multiplets of Ce I, Nd I, Sm I, Gd I, Dy I and Er I were measured by the atomic-beam magnetic-resonance technique. Intermediate coupling, relativistic and diamagnetic corrections recently calculated by Judd and Lindgren (1960) are shown to give good agreement with the measured g values of Nd, Sm, Dy and Er and it is concluded that the ground configurations of Dy I and Er I are $4f^{10}\,6s^2$ and $4f^{12}\,6s^2$ respectively. The Gd I results are consistent with fairly pure LS coupling between the 5d and 4f electrons and the Ce I measurements indicate a strong interaction between the ground state, which is probably $5d\,4f\,6s^2$, ^3H, and a low-lying state from another configuration such as $5d^2\,4f\,6s$, ^5I.

19586 THE SPECTRUM OF IONIZED BERYLLIUM. Be II. L.Johansson.

Ark. Fys. (Sweden), Vol. 20, Paper 33, 489-98 (1961).

The spectrum was studied by using a hollow-cathode discharge. Wavelengths were determined for 46 lines between 12 100 and 1500 A, and the term system was revised and extended with the aid of the measurements.

19587 STRUCTURE OF THE SPECTRUM OF DOUBLY IONISED BROMINE. Y.Bhupala Rao.

Indian J. Phys., Vol. 35, No. 8, 386-400 (Aug., 1961).

The earlier analysis of the spectrum of Br III is revised and extended. A large number of levels belonging to the various configurations are newly identified, leading to the classification of more than 200 lines, which bring the total of classified lines to about 230. The doublets are correctly identified and are confirmed by the intercombinations with the quartets. The third ionization potential of bromine given in the earlier analysis is verified to be correct.

19588 OSCILLATOR STRENGTHS OF THE SPECTRAL LINES OF CALCIUM. Yu.I.Ostrovskii and N.P.Penkin.

Optika i Spektrosk. (USSR), Vol. 10, No. 4, 429-35 (April, 1961). In Russian.

The relative f numbers of thirty-four Ca I lines, situated between 2275 and 6572 A were measured by the hook method. The results of the measurements are compared with the data of other authors. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 4, 219-22 (April, 1961)].

19589 X-RAY FLASH SPECTRA OF Fe, Ni AND Cu. P.O.Schörling.

Ark.Fys. (Sweden), Vol. 19, Paper 5, 47-67 (1961).

K-spectra of Fe, Ni and Cu from an X-ray flash tube with low inductance were recorded photographically and compared with spectra from an ordinary X-ray tube. In the flash spectrum the satellite $K\beta'$ was much stronger, the $K\alpha_1$ line was broadened on both sides, the $K\alpha_2$ line on the low energy side, and the $K\beta_{1,3}$ line on the high energy side. The probable cause of these effects is multiple ionization by successive collisions with incident cathode electrons. The results support Parratt's explanation (Abstr. 11087 of 1959) of the origin of $K\beta'$ and the asymmetry of $K\alpha_1$ and $K\alpha_2$. An alternative theory by Kakuschadse (Abstr. 12783 of 1959) is rejected.

19590 SPECTRAL STRUCTURE OF DOUBLY AND TREBLY IONIZED HAFNIUM.

P.F.A.Klinkenberg, T.A.M.Van Kleef and P.E.Noorman.

Physica (Netherlands), Vol. 27, No. 12, 1177-88 (Dec., 1961).

A level scheme is presented which accounts for more than 80% of the observed Hf III lines. All levels in the low even group and the odd group are given quantum assignments. The configurations involved are $5d^2$, 5d6s, $6s^2$, 5d6p and 6s6p with $5d^2\,^3F_2$ being the ground state of the ion. The only predicted level which could not be located, is $5d^2\,^1S_0$. Some assignments are made also in the high even system of levels, where fragments of 5d7s and 5d6d have been detected. The ionization potential of Hf III is found to be 23.3 V. The fundamental levels of Hf IV have been established. They leave unexplained most of the lines attributed to that spectrum, but account for the strongest and most characteristic ones. The ionization potential derived for Hf IV is 33.3 V. The structure of the two spectra is discussed in connection with related systems.

19591 COLLISION INDUCED SATELLITE BANDS OF In AND Tl LINES IN THE PRESENCE OF RARE GASES.

Shang Yi Ch'en, M.R.Atwood and T.H.Warnock.

Physica (Netherlands), Vol. 27, No. 12, 1170-6 (Dec., 1961).

The satellite bands associated with the shorter wavelength components of the first four members of the sharp and the diffuse series doublets of thallium and some lines of indium were observed in the presence of the rare gases. The violet band separation of bands associated with the first member of the diffuse series (Tl 2768) is larger than the corresponding bands for the first member of the sharp series (Tl 3776). The rapid decrease in the violet band separation with the members of the series, the decrease in the violet band separation with the mass of the perturber, and the presence of red bands for only heavy gases are results analogous to those obtained for the alkali principal series lines. The differences in the observations in these two classes of metal (alkali and boron group) lines are: (1) A violet band associated with each component line of the first sharp series doublets of both In and Tl was observed while in the alkali metals only one violet band was reported on the violet side of the entire principal series doublet. The violet band separation for the longer wavelength component (${}^2P_{3/2}$) of the sharp series doublet (Tl 5350) is nearly twice that of the shorter wavelength component (Tl 3776). (2) The red band separation is larger for the heavier metal of the boron group, but the reverse is true for the alkali metals.

DETERMINATION OF THE NUCLEAR MAGNETIC MOMENT OF Hg^{199} FROM THE HYPERFINE STRUCTURE OF THE Hg I 5461 A LINE. See Abstr. 19342

DETERMINATION OF THE NUCLEAR MAGNETIC MOMENT OF Na^{23} FROM THE HYPERFINE STRUCTURE OF THE ABSORPTION LINES D$_1$ AND D$_2$. See Abstr. 19343

19592 THE SPECTRUM OF THE NEUTRAL NITROGEN ATOM IN THE LEAD-SULFIDE REGION.

K.B.S.Eriksson and I.Johansson.
Ark. Fys. (Sweden), Vol. 19, Paper 16, 235-48 (1961).

In the spectrum of the neutral nitrogen atom, N I, wavelengths have been determined for 113 lines in the region 18751-11998 A by using a scanning spectrograph with a Kodak Ektron detector and a modulated radiation source, viz. a hollow cathode and an electrodeless discharge. A system of accurately connected energy levels, including the complete configurations 2p^3, 2p^4, 3s, 4s, 5s, 3d, and 4f, was derived. A number of infrared intercombination lines fix the doublet and quartet systems in relation to each other; the laboratory data confirm Bowen's measurements of forbidden N I lines in nebular spectra. The empirically established 4 f levels were found to follow the formulae for intermediate pair coupling. With the support of theory, some 5f levels are also determined.

19593 TIME-RESOLVED EMISSION SPECTRA OF A SPARK DISCHARGE IN NITROGEN AND IN AIR IN THE WAVELENGTH RANGE 5000-10 000 A.

M.P.Vanyukov, V.R.Muratov and I.A.Mukhitdinova.
Optika i Spektrosk. (USSR), Vol. 10, No. 4, 561-3 (April, 1961).
In Russian.

Spectra are published at 0.3 and 1 μsec from the start of a spark discharge produced at atmospheric pressure with an applied voltage of 12 kV. Oscillograms are also given for selected wavelengths. It is concluded that, under the discharge conditions used, the main difference between the spectra is the presence of several arc lines of oxygen in the air spark. An increase of the self-inductance of the circuit from 0.2 to about 50 μH causes a general decrease in spectral intensity. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 4, 294 (April, 1961)]. G.V.Marr

19594 ISOTOPE SHIFT AND HYPERFINE STRUCTURE IN THE SPECTRUM OF TELLURIUM.

H.G.Kuhn and R.Turner.
Proc. Roy. Soc. A (GB), Vol. 265, No. 1320, 39-45 (Dec., 1961).

With the use of enriched samples of the stable isotopes of tellurium, the isotope shifts in the spark line 4049 A were studied. Fabry—Perot fringes due to this line were measured against a mercury reference line; also the hyperfine structures of the odd isotopes were measured. The shifts in the even isotopes are compared with those in adjacent elements and discussed in terms of nuclear deformation. The odd-even staggering was found to be extremely large in tellurium. The ratio of the widths of the hyperfine structures of the isotopes 123 and 125 agrees, within the experimental limits of error of about 1%, with the ratio of the nuclear magnetic moments.

IONIZATION AND EXCITATION OF HYDROGEN IN A PLASMA. See Abstr. 19595

19595 IONIZATION AND EXCITATION OF HYDROGEN. I. ELEMENTARY PROCESSES FOR THE UPPER LEVELS.

G.S.Ivanov-Kholodnȳi, G.M.Nikol'skii and R.A.Gulyaev
Astron. Zh. (USSR), Vol. 37, No. 5, 799-811 (Sept.-Oct., 1960).
In Russian.

Considers the lowering of the ionization continuum due to the electric field of ions. Expressions are obtained for the rate in a hydrogen plasma of: charge exchange, excitation, and de-excitati by electron collision, ionization by electron collision, and by radi tion, total photorecombination on all levels, and recombination as the result of three-body collisions. The relative importance of these processes for ground and upper levels is estimated. [Engli translation in: Soviet Astron.—AJ (USA), Vol. 4, No. 5, 754-65 (March-April, 1961)].

19596 THE IONIZATION AND EXCITATION OF HYDROGEN II. THE NUMBER OF OBSERVED LINES IN A SERIE

G.S.Ivanov-Kholodnȳi and G.M.Nikol'skii.
Astron. Zh. (USSR), Vol. 38, No. 3, 455-62 (1961). In Russian.

The number of levels and the population of upper levels of hydrogen are considered. It is shown that there is a lowering of t ionization continuum and a decrease in the population of the high levels, as compared with the Boltzmann distribution, due to diffus ness of the levels as a result of the impact effect. The population the upper levels and the number of lines in the series are estimat [English translation in: Soviet Astron.—AJ (USA), Vol. 5, No. 3, 339-43 (Nov.-Dec., (1961)].

19597 THEORY OF COLLISION TRANSFER OF EXCITATIO IN HELIUM.

C.C.Lin and R.G.Fowler.
Ann. Phys. (USA), Vol. 15, No. 3, 461-9 (Sept., 1961).

A theory is presented to explain the multiple state mechanism for the transfer of excitation from singlet to triplet states in heliu atoms proposed by St.John and Fowler (Abstr. 9915 of 1961). The spin—orbit interactions produce substantial singlet—triplet mixing in the F states which is responsible for the transfer. It is shown that a helium atom in an n^{1}P state, after colliding with a normal atom, transfers primarily into the "mixed" nF states which in tur cascade to 3^{3}D. The population of the 3^{3}D state is calculated as 4.0×10^5 atoms/cm^3 as compared to 1.28×10^5 atoms/cm^3 from experiment.

19598 ON THE CALCULATION OF PHOTOIONIZATION ABSORPTION IN ATOMIC GASES.

L.M.Biberman, G.É.Norman and K.N.Ulyanov.
Optika i Spektrosk. (USSR), Vol. 10, No. 5, 565-9 (May, 1961).
In Russian.

The method of calculation of the photoionization absorption by multielectron atoms suggested earlier (Abstr. 19609 of 1960) was applied to lithium, aluminium, mercury, krypton, xenon, and argon. It is shown that the dependence of the absorption coefficient on frequency depends on the atomic structure. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 5, 297-9 (May, 1961)]

19599 THE EFFECT OF EXTERNAL FIELDS ON THE ANGULAR CORRELATIONS AND RESONANCE PROCESSES DURING QUANTUM TRANSITIONS.

L.G.Zastavenko and M.I.Podgoretskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1023-6 (Oct., 196
In Russian.

The scattering of light and γ-rays in isolated and overlapping magnetic sublevels is considered. A new method is discussed for the experimental determination of the Stark constant and the gyromagnetic ratio. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 711-13 (April, 1961)].

19600 EXPERIMENTAL STUDY OF THE LONGITUDINAL ANGULAR DISTRIBUTIONS OF PHOTO-ELECTRONS FROM THE INNER ELECTRON SHELLS OF URANIUM.

Z.Sujkowski.
Ark. Fys. (Sweden), Vol. 20, Paper 17, 269-88 (1961).

Longitudinal angular distributions of photoelectrons from uranium targets were studied using the beta-spectrometric technique. The distribution functions were obtained for the following gamma-ray energies and electron shells: 103 keV (L$_I$ + L$_{II}$, L$_{III}$ and M shells), 279 keV (K shell) and 2750 keV (K shell). The true K 279 photoelectron distribution was obtained by experimental determination of the scattering and geometrical (finite size) distortion effects. The distribution is compared to the theoretical erential cross-sections obtained from Sauter's formula (1931) from numerical calculations based on relativistic formulae d for any Z (Nagel, Abstr. 4909 of 1961). Very good agreement the latter is obtained. The ratios of the photoelectric absorp- in different shells at hν = 103 keV are determined to be: $+ \tau_{L_{II}}/\tau_{L_{III}} = 3.03 \pm 0.15$; $\tau_L/\tau_M = 3.70 \pm 0.20$. Comple- ntary measurements of these ratios at hν = 81.0 keV and hν = 79 keV are reported. The value $\tau_{L_{II}}/\tau_{L_{III}} = 0.92 \pm 0.15$ for = 81 keV is given. Other experimental data available on these os are discussed. It is shown that the results are in disagree- nt with existing theoretical predictions.

19601 MOMENTUM—SPIN CORRELATIONS IN PHOTO-ELECTRIC EFFECT AND IN SINGLE QUANTUM SITRON ANNIHILATION. H.Kolbenstvedt and H.Olsen.

ovo Cimento (Italy), Vol. 22, No. 3, 610-30 (Nov. 1, 1961).

The transverse polarization of photoelectrons and the photon ission asymmetry with respect to the polarization plane in gle quantum annihilation of transversely polarized positrons is culated in the lowest non-vanishing order Born approximation. e effects are of the same nature and of the same order of gnitude as the polarization and asymmetry effects in Mott attering. The momentum spin correlation in quantum theory of diation is shown to be proportional to the imaginary part of the trix element integrals. The fact that the correlation only occurs the second-order Born approximation, the first-order Born proximation matrix element integrals being real, is closely lated to time reversal invariance.

THE TEMPERATURE DEPENDENCE OF CERTAIN PROCESSES HICH ARE DETERMINED BY ELASTIC COLLISIONS BETWEEN ECTRONS AND ATOMS. See Abstr. 18793

19602 A SCHEMATIC MODEL FOR THE IMPACT EXCITATION OF ATOMS. B.L.Moiseiwitsch.

oc. Phys. Soc. (GB), Vol. 78, Pt 5(i), 661-72 (Nov., 1961).

The third-order approximation is used to derive simple alytical expressions for the partial cross-sections corresponding the scattering of high-energy charged particles by a schematic odel atom involving matrix elements having a r^{-2} radial depend- ce.

19603 THE IMPORTANCE OF CONSERVATION CONDITIONS IN DISTORTED WAVE CALCULATIONS.

.B.Somerville.

roc. Phys. Soc. (GB), Vol. 78, Pt 5(i), 695-7 (Nov., 1961).

Some recent results of Vainstein (1960), using the distorted ave approximation for the 3s-3p transition in electron—sodium om collisions are modified on the basis of a method introduced y Seaton (Abstr. 3507 of 1961) which ensures that the conservation ondition is satisfied. The resulting cross-sections lie much closer those obtained by experiment.

19604 THE POTENTIAL MODEL TREATMENT OF THE SCATTERING OF ELECTRONS BY ATOMS AND THE XISTENCE OF NEGATIVE IONS. F.B.Malik and E.Trefftz.

. Naturforsch. (Germany), Vol. 16a, No. 5, 492-500 (May, 1961).

The low energy scattering of electrons by different neutral toms was treated by assuming that the atomic wave functions re- nain unchanged even at the presence of the scattered particle and y neglecting the exchange between the scattered electron and the ound electrons. The potential term in the differential equation of he scattered particle is exactly the atomic potential of the neutral tom and is approximated by analytical expressions, yielding the otential scattering equation. The variational treatments roposed by Hulthén and by Kohn (Abstr. 1511 of 1949), and a elated one suggested by Malik (Abstr. 5812 of 1959), are applied to olve this equation for a Hartree atom with $l = 0$. The scattering by le, C and N is treated explicitly and the results of He indicate that n this way good results may be obtained without going into the great omplexity of the many body problem. It is further pointed out that he study of scattering by neutral atoms near zero energy under this nodel may serve as a possible means to investigate the existence of lifferent negative ions and their number of bound states. It seems rom this point of view that He^-, C^- and N^- for this model may exist nd have one bound s-state.

19605 ELECTRON SCATTERING IN THE THOMAS—FERMI MODEL. T.Titts [T.Tietz].

Zh. eksper.teor. Fiz. (USSR), Vol. 39, No. 5(11), 1347-8 (Nov., 1960). In Russian.

The differential cross-section for electron scattering by atoms is calculated in the Thomas—Fermi approximation with the Latter potential (Abstr. 8169 of 1955). Results of numerical integration are presented for Ne, Si, and S, and these are compared with results obtained by the Hartree method. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 5, 940 (May, 1961)].

19606 HARTREE—FOCK ATOMIC SCATTERING FACTORS FOR THE NEUTRAL ATOM IRON TRANSITION SERIES.

A.J.Freeman and R.E.Watson.

Acta cryst. (Internat.), Vol. 14, Pt. 3, 231-4 (March 10, 1961).

Atomic scattering factors for the lowest neutral atom $3d^{n-2}4s^2$ states were calculated for the atoms Ti through Zn using recently computed Hartree—Fock analytic wave-functions. Except for Cr and Cu, these calculations are for the ground state of the atom. Also given are tabulations of the individual transforms for the 3d and 4s electrons. The results are compared with previous calculations for these atoms and the effect of the 4s electrons on the form factors of the 3d and core electrons is discussed.

19607 RESONANCE CHARGE TRANSFER BETWEEN H(1s) AND H⁺ CALCULATED BY MEANS OF AN APPROXIMATION BASED ON AN EXPANSION IN MOLECULAR EIGENFUNCTIONS. A.F.Ferguson.

Proc. Roy. Soc. A (GB), Vol. 264, 540-6 (Dec. 5, 1961).

The cross-section for the process $H^+ + H(1s) \rightarrow H(1s) + H^+$ is calculated for proton energies between 1 and 50 keV by means of the perturbed stationary-state approximation, with allowance for momentum transfer effects. Allowance for momentum transfer is found to decrease the cross-section by 5% at 2 keV, by 16% at 5 keV and by 45% at 20 keV. For energies below about 20 keV, the calculations are within 5% of those of McCarroll (following abstract), who uses an approximation based on atomic eigenfunctions. The results are in satisfactory accord with the experimental data of Fite et al. (Abstr. 13408 of 1960) in the lower part of the energy range covered (where capture into excited states is unimportant).

19608 RESONANCE CHARGE TRANSFER BETWEEN H(1s) AND H⁺ CALCULATED BY MEANS OF AN APPROXIMATION BASED ON AN EXPANSION IN ATOMIC EIGENFUNCTIONS. R.McCarroll.

Proc. Roy. Soc. A (GB), Vol. 264, 547-57 (Dec. 5, 1961).

An expression for the cross-section describing electron capture by protons in atomic hydrogen is derived from an expansion based on atomic wave-functions. Full account is taken of momentum transfer and of the non-orthogonality of the wave-functions of the initial and final states by the method due to Bates (Abstr. 475 of 1960). The cross-sections are computed for proton energies from 100 eV to 1 MeV. In the low-energy limit, the results agree with the p.s.s. calculations of Dalgarno and Yadav (1953) and in the high-energy limit with the calculations of Brinkman and Kramers (1930).

19609 ADJUSTMENT OF RELATIVE NUCLIDIC MASSES. II. $70 < A < 200$.

L.A.König, J.H.E.Mattauch and A.H.Wapstra.

Nuclear Phys. (Internat.), Vol. 28, No. 1, 1-28 (Nov., 1961).

For Pt I see Abstr. 12266 of 1961. Describes the second part of the least squares computation of nuclidic masses from all available data. A compilation of all measurements relevant to the mass range $70 < A < 200$ is given. See also following abstract.

19610 ADJUSTMENT OF RELATIVE NUCLIDIC MASSES. III. $A \geq 200$. A.H.Wapstra.

Nuclear Phys. (Internat.), Vol. 28, No. 1, 29-41 (Nov., 1961).

Describes the procedure used in computing nuclidic masses for $A \geq 200$ from tabulated experimental data, and gives a list of all reaction energies of some types of reactions calculated from the mass list. See also preceding abstract.

19611 MASS OF THE Pu^{240} ISOTOPE.

R.A.Demirkhanov and V.V.Dorokhov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1033-4 (April, 1961). In Russian.

The mass of the Pu^{240} isotope was measured with a mass spectrograph and found to be 240.130316 ± 0.000130 a.m.u. This value is extensively compared with values found by other workers and is in good agreement. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 727-8 (Oct., 1961)]. C.J.Batty

Isotopes

19612 ISOTOPE MASSES AND BINDING ENERGY OF NUCLEI IN THE REGION FROM STRONTIUM TO RUTHENIUM.
R.A.Demirkhanov, V.V.Dorokhov and M.I.Dzkuya.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1572-82 (June, 1961).
In Russian.

A double-focusing mass-spectrograph was employed to measure the masses of stable isotopes in the region $84 \leq A \leq 104$. The average resolving power of the instrument was 50 000-60 000. Twenty-five isotope masses were measured. The measurements were performed by checking the "internal" consistency of the results. For this purpose 60 mass doublets were measured. Most of the isotope masses were measured from 3-4 doublets of different organic composition. Besides the 25 stable isotope masses,those of 59 radioactive isotopes were determined. The binding energy per nucleon, binding energy of the last neutron (B_n) and proton (B_p) and neutron (P_n) and proton (P_p) pairing energies were calculated on basis of these data. The sharp break in the nucleon binding energy curve and the discontinuities in the energies B_n and P_n in nuclei containing 50 neutrons definitely confirm the presence of the "magic" number $N = 50$. Furthermore, anomalously large values of B_n and P_n were found in nuclei with $N = 48$. On the other hand, no nonmonotonous variation of the indicated parameters was observed for $Z = 40$ which signifies that no "subshell" exists for $Z = 40$. [English translation in: Soviet Physics—JETP (USA)].

THE ABUNDANCES OF THE HELIUM AND NEON ISOTOPES PRODUCED BY THE COSMIC RADIATION IN SOME IRON METEORITES. See Abstr. 951

A HIGH TEMPERATURE SPUTTERING ION SOURCE FOR A LABORATORY ISOTOPE SEPARATOR. See Abstr. 18949

19613 ISOTOPE ENRICHMENT OF Mg, Ca, Sr AND Ba BY ION MIGRATION IN MOLTEN HALIDES.
A.Neubert and A.Klemm.
Z. Naturforsch. (Germany), Vol. 16a, No. 7, 685-92 (July, 1961).
In German.

The isotopic mass effect on the mobility of alkaline-earth cations in molten halides was determined by electrolysis in order to explore the possibilities of isotopic enrichment by differences in migration of isotopes. A study of the cost of enriching natural Ca in Ca^{46} is included. C.R.Ward

Mesic Atoms

19614 THE IMPORTANCE OF A TWO STAGE DECAY MODE OF K^- MESIC ATOMS. J.R.Rook.
Rutherford Jubilee Conference, Manchester, 1961 (see Abstr. 16610 of 1961), Paper C 3/5, p. 399-400.

An estimate was made of the relative probabilities of two modes of decay of K^- mesic atoms in nuclear emulsion. The processes considered are the direct

$$K^- + P \rightarrow \Sigma\pm + \Pi\mp$$

and the process where the meson scatters from a single nucleon into a bound state. The probabilities are calculated in the lowest order of perturbation theory. It is found that the direct process predominates over the scattering process by a factor of over 100. It is concluded that the scattering process does not explain the relatively high observed frequency of decays involving two nucleons.

19615 NUCLEAR FINITE SIZE EFFECTS ON THE INTERNAL CONVERSION IN THE μ-MESONIC He^3 atom.
H.Narumi and S.Matsuo.
Progr. theor. Phys. (Japan), Vol. 26, No. 2, 221-30 (Aug., 1961).

The internal conversion processes in the μ-mesic He^3 atom following nuclear fusion reactions by μ-mesons at low temperature are analysed, where the finite size effects of the He^3 nucleus play an important role, so that the μ-mesic irregular solutions outside the nucleus are considered. The calculated reaction rates give reasonable agreement with experimental results by Ashmore et al. (Abstr. 1270 of 1958) and Alvarez et al. (Abstr. 5651 of 1957).

19616 DETERMINATION OF THE HYPERFINE SPLITTING ENERGY OF THE 1s MUONIUM STATE.
A.O.Vaisenberg.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 853-5 (Sept., 196
In Russian.

The hyperfine splitting energy of the ground state of muonium estimated on the basis of available experimental data on the dependence of the μ^+-meson polarization in a nuclear emulsion o the magnetic field strength. [English translation in: Soviet Physi JETP (USA)].

19617 NUCLEAR POLARIZATION OF MESIC ATOMS WITH SPHERICALLY SYMMETRIC MESON STATES.
W.Greiner.
Z. Phys. (Germany), Vol. 164, No. 4, 374-88 (1961). In German.

The polarization of the nuclear core by the μ-meson in a μ-mesonic atom is calculated using spherically symmetric meson states. The nucleus is represented by the hydrodynamic model of Jensen and Steinwedel. Within this framework it is shown that the collective polarization of the nucleus causes a shift in the $1S_{1/2}$ term by about 1 keV in the case of lead. The effect becomes rapidly more important for the higher lying levels. The single particle polarization, not included in the hydrodynamic model is estimated to be less than 100 eV. S.J.St-Lor

MOLECULES

19618 VIBRATIONAL EXCITATION OF DIATOMIC MOLECULES DUE TO NUCLEAR RECOIL.
J.Fiutak and L.Wolniewicz.
Bull. Acad. Polon. Sci. Ser. Sci. math. aston. phys. (Poland), Vol. 9, No. 7, 557-60 (1961).

The calculation of the probability of excitation of vibrational and rotational motions by nuclear recoil, previously treated for diatomic harmonic oscillators (Steinwedel and Jensen, Abstr. 294 1947 and Wolfsberg, Abstr. 2514 of 1956), is extended to the case a Morse potential. Probabilities for the ground state of H_2 are compared with those for the harmonic approximation. For large mean energy transfers, anharmonicity increases the probability o vibrational excitation, and the mean value of the final vibrational quantum number, but the mean vibrational energy is independent o the form of the potential. J.Sherid

19619 THE INTERPRETATION OF VIBRATION-ROTATION SPECTRA OF MOLECULES WITH TETRAHEDRAL OR OCTAHEDRAL SYMMETRY. J.Moret-Bailly.
Cahiers de Phys. (France), Vol. 15, 237-314 (June-July, 1961).
In French.

Deals with the interpretation of the vibration-rotation spectra of spherical tops. Values for the energy levels are obtained in the form $E = E_0 + E_1 + E_2 \ldots$ by a perturbation calculation carried out terms of a transformed Hamiltonian in which H^* is represented by a matrix which uses coupled functions with certain properties for the basis functions. As an example of the use of the theory develo in this paper the frequencies of the vibration-rotation lines in the and R branches of the ν_4 band of methane are calculated.
W.J.Orville-Thom

19620 THE IDENTIFICATION OF VIBRATIONAL LEVELS IN H_2^+. L.Kerwin, P.Marmet and E.Clarke.
Canad. J. Phys., Vol. 39, No. 8, 1240 (Aug., 1961).

The ionization potential of H_2 was measured and used to identify earlier results (Abstr. 17732 of 1960) on the vibrational levels in the $^2\Sigma_g$ state of H_2^+. Evidence for and against applicatio of the Franck—Condon principle to the hydrogen molecule is discussed. R.G.C.Arri

19621 POTENTIAL ENERGY CURVES FOR THE X $^1\Sigma_g^+$ AND B $^1\Sigma_u^+$ STATES OF HYDROGEN.
I.Tobias and J.T.Vanderslice.
J. chem. Phys. (USA), Vol. 35, No. 5, 1852-5 (Nov., 1961).

The recently reported accurate data of Herzberg and Howe (Abstr. 7943 of 1959) are used to calculate the potential energy curves for the X $^1\Sigma_g^+$ and B $^1\Sigma_u^+$ states of hydrogen by the Rydber Klein—Rees (RKR) method. The results are compared with the re- sults of the quantum calculations of Kolos and Roothaan and Dalga

Lynn. The agreement is good; in fact, the interaction energy obned by Dalgarno and Lynn for the ground state agrees with the R values to within 2% in the region where the two curves overlap. e rotational predissociation observed in the v" = 14 level of the Σ_g^+ state is discussed. It appears as if there may exist here an sual case of a sharp spectral line associated with a state which is y close in energy to the maximum of a potential barrier.

19622 TABLES FOR THE INTERNAL ROTATION PROBLEM.

M.Hayashi and L.Pierce.

chem. Phys. (USA), Vol. 35, No. 3, 1148-9 (Sept., 1961).

Describes tables which extend those described in Abstr. 2606 1958, giving values of the same matrix elements for some ermediate parameter values and giving also matrix elements of n 3α and ($1-\cos 3\alpha$), needed for perturbation treatments of olecules with more than one internal top. The tabulation of urier coefficients and perturbation sums in Abstr. 8717 of 1959 is so extended. J.Hawgood

19623 CALCULATION OF INTERACTION MATRIX ELEMENTS FOR ASYMMETRIC ROTORS WITH RESULTANT ELECTRONIC SPIN AND NUCLEAR SPIN.

R.F.Curl, Jr and J.L.Kinsey.

chem. Phys. (USA), Vol. 35, No. 5, 1758-65 (Nov., 1961).

The application of Racah or vector recoupling coefficients to the lculation of interaction matrix elements for asymmetric rotors th resultant electronic and nuclear spin is outlined. This approach compared with Van Vleck's method of reversed angular momenta.

19624 INFLUENCE OF THE ROTATIONAL LEVELS ON THE SCATTERING OF SLOW NEUTRONS BY GASEOUS ETHANE.

G.W.Griffing.

hys. Rev. (USA), Vol. 124, No. 5, 1489-93 (Dec. 1, 1961).

The partial differential cross-section for gaseous methane was omputed at incident neutron energies of 0.015 and 0.0252 eV at cattering angles of 16.3° and 26.0°. It is found that the quantum ature of the rotational levels has a marked effect on the scattering neutrons. By comparing the results of these computations with e results of experiments (Abstr. 15945 of 1961) it is demonstrated at this effect has also been observed in the experiments.

19625 SCATTERING OF SLOW NEUTRONS BY THE WATER MOLECULE.

P.G.Khubchandani and A.Rahman.

eactor Sci. (GB), Vol. 11, No. 2-4, 89-94 (Feb., 1960).

The elastic scattering is calculated by considering it as a rigid symmetric rotator, following the method of Goryunov (Abstr. 2547 f 1960). The partial scattering from each rotational state is calculated separately since the incident neutron energy considered is of e same order of magnitude as the rotational level separation. It is hown that in taking the thermal average at T = 300°K the contribuon to the elastic scattering from rotational states with quantum umber $j \geq 4$ is not negligible, as had been supposed by Goryunov. his is true also for the total scattering which is calculated for just ne incident neutron energy, 0.0006 eV. The calculation gives a alue slightly higher than the experimental value and it is shown that his is due to the neglect of zero-point vibrations of the molecule.

19626 THE SKELETAL MODES OF LONG-CHAIN MOLECULES.

S.B.Field and D.H.Martin.

Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 625-7 (Oct., 1961).

Observations on the extreme infrared spectrum of $C_{11}H_{23}.CO.C_{11}H_{23}$ at 100°K confirm the predictions of Szigeti (Abstr. 4534 of 1961) on the torsional oscillations of long-chain paraffin olecules. G.I.W.Llewelyn

19627 TORSIONAL VIBRATIONS OF LONG-CHAIN HYDROCARBONS.

B.Szigeti.

Proc. Roy. Soc. A (GB), Vol. 264, No. 1317, 198-211 (1961).

The torsional vibrations of long-chain hydrocarbons represent rotational oscillations of small amplitude around the carbon—carbon bonds. On the assumption that the forces hindering rotation around the various C—C bonds are equal and independent of each other, the frequencies of isolated long-chain hydrocarbon molecules n the plane configuration are calculated exactly. In the case of L carbon atoms, there are L−3 modes of torsional vibration. The frequencies extend from a maximum value ω_m in the far infrared region, down to low values. In the solid state, the higher and medium frequencies are hardly affected by intermolecular interaction, but the lowest torsional frequencies are modified. The ntroduction of a polar group into the molecule makes the torsional vibrations active in the absorption spectrum. In the following abstract, the results are used to derive the torsional absorption spectrum of dipolar long-chain substances in the solid state.

19628 TORSIONAL ABSORPTION SPECTRA OF LONG-CHAIN SUBSTANCES IN THE SOLID STATE.

B.Szigeti.

Proc. Roy. Soc. A (GB), Vol. 264, No. 1317, 212-20 (1961).

The absorption spectra connected with the torsional vibrations of long-chain substances are calculated. Ketones are treated in detail, but the results can also be applied to other long-chain molecules with simple dipolar groups. It is shown that the torsional frequencies of a long-chain ketone are very similar to those of the parent hydrocarbon. But the presence of the ketone group makes the vibrations active in the spectrum. For a molecule with L carbon atoms, there are L−3 torsional vibrations. For isolated molecules in the plane configuration, the frequencies range from a maximum ω_m in the far infrared, down to low values. For an asymmetric ketone all the torsional frequencies are active, while for a symmetric ketone only half of them are active. However, the absorption intensity for frequencies near ω_m is expected to be very weak. In the solid state, the high and medium torsional frequencies are hardly affected by intermolecular interaction. In this region, therefore, the frequencies calculated for isolated molecules should be approximately correct. The low torsional frequencies, on the other hand, are strongly affected by intermolecular forces in the solid. This effect is discussed, and the absorption due to rigid libration of the molecules is also considered.

19629 FERMI RESONANCE IN THE CASE OF CARBON TETRACHLORIDE.

M.P.Lisitsa and V.L.Strizhevs'kii.

Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 1, 34-9 (1960). In Ukrainian.

Compares theory with experiment for three Fermi resonance doublets of carbon tetrachloride. In the case of gaseous CCl_4 the Theoretical value of the splitting κ and the ratios of the intensities of the resonating components agree satisfactorily with experiment. The authors determined the distances Δ between unperturbed levels, and the unperturbed frequencies of the fundamental modes of the gaseous and the liquid CCl_4 molecule.

19630 MEASUREMENT OF THE RELAXATION TIME OF A VIBRATION OF N_2O BY AN INFRARED METHOD.

G.Gauthier and J.Marcoux.

Canad. J. Phys., Vol. 39, No. 8, 1130-7 (Aug., 1961). In French.

Nitrous oxide, at 10 mm pressure, was pumped from a hot (150°C) region through an adjacent cold (30°C) region. Infrared traces of the band at 4.55 μ were taken in the static gas at 150° and 30°C, and in the pumped gas with optical paths parallel to the hot—cold junction and between 6 and 27 cm from it. The width of the band diminished as the distance into the cold section increased, and was used to calculate the vibrational temperature of the gas, use being made of calibration experiments in which the width of the band was measured at various temperatures during thermal equilibrium. The vibrational temperature in the pumped gas was higher than the translational temperature at the same points, as measured on thermocouples, the difference reaching a maximum of about 30°C when the gas was about half cooled. The data yield values between 0.007 and 0.018 sec for the relaxation time of the vibration at 10 mm pressure, corresponding to relaxation times of the order of 10^{-4} sec at 1 atm. These are about 100 times as great as values obtained from ultrasonic measurements. J.Sheridan

19631 INFLUENCE OF THE ROTATIONAL STRUCTURE OF MOLECULAR BANDS ON LIGHT ABSORPTION BY LAYERS OF FINITE THICKNESS.

V.N.Soshnikov.

Optika i Spektrosk. (USSR), Vol. 10, No. 4, 448-56 (April, 1961). In Russian.

A numerical calculation for a model consisting of a random distribution of rotational lines of Lorenz—Doppler shape with a Boltzmann intensity distribution. A comparison is made with the model of equally intense lines and with the case of an exponential intensity distribution. The possibility and method of applying the the relationships derived to a real spectrum are discussed. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 4, 229-33 (April, 1961)].

19632 A NOTE ON THE BAND SPECTRA OF BiF AND SbF.

G.D.Rochester.

Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 614 (Oct., 1961).

Data on the emission and absorption spectra of BiF and SbF are correlated and it is deduced that both the ground state and the upper state A in BiF have multiplet structures. G.I.W.Llewelyn

19633 INTENSITY DISTRIBUTION IN THE ROTATIONAL STRUCTURE OF SPECTRA OF ISOTOPIC NITROGEN MOLECULES AND ISOTOPIC ANALYSIS.

K.A.Oganezov and R.R.Shvangiradze.

Optika i Spektrosk. (USSR), Vol. 10, No. 5, 577-82 (May, 1961). In Russian.

An experimental study of the intensity relationship of the rotational lines of bands of the $B\,^2\Sigma_u^+ \rightarrow X\,^2\Sigma_g^+$ electronic transition of the isotopic molecules $(N_2^{14})^+$, $(N^{14}N^{15})^+$, and $(N_2^{15})^+$ was carried out. It was established that the sum of the statistical weights of two neighbouring rotational levels and also the sum of the corresponding transition probabilities have the same value for all three molecules, with intensity alternation of the lines in the bands of the individual molecules corresponding to the known values of the nuclear spins of N^{14} and N^{15}. An accurate photoelectric method of determining the isotopic constitution of nitrogen was developed for the range of concentration of the individual isotopes from 1 to 99%. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 5, 303-5 (May, 1961)].

19634 ROTATIONAL ANALYSIS OF THE BLUE-GREEN AND ORANGE SYSTEMS OF YTTRIUM OXIDE.

U.Uhler and L.Åkerlind.

Ark. Fys. (Sweden), Vol. 19, Paper 1, 1-16 (1961).

The blue-green and the orange systems of YO were photographed at high dispersion. Rotational analysis of the 0,0 bands of both systems was carried out. The analysis confirms the earlier assumption that the systems represent a $^2\Sigma - {}^2\Sigma$ and a $^2\Pi - {}^2\Sigma$ transition respectively. The lower states of the systems are identical ($X^2\Sigma$). The upper state of the blue-green system ($B^2\Sigma$) shows a very large spin-splitting. The upper state of the orange system A $^2\Pi$ belongs to Hund's case a. The constants are:

State	B_0 cm^{-1}	D_0 cm^{-1}	r_0 cm
B	0.3722	0.38×10^{-6}	1.828×10^{-8}
A	0.3857	0.35×10^{-6}	1.795×10^{-8}
X	0.3881	0.32×10^{-6}	1.790×10^{-8}

$B^2\Sigma - X^2\Sigma$: $\gamma' = 0.148$ cm^{-1} $\sigma_{00} = 20741.92$ cm^{-1}

$A^2\Pi_{1/2} - X^2\Sigma$: $a = 0.151$ cm^{-1} $\sigma_{00} = 16294.72$ cm^{-1}

$A^2\Pi_{3/2} - X^2\Sigma$: $\sigma_{00} = 16722.75$ cm^{-1}

The multiplet splitting constant A = 428.03 cm^{-1}.

19635 HIGH RESOLUTION INFRARED ABSORPTION SPECTRA IN THE 1.65 μ REGION FOR MOLECULES OF $C_{3\nu}$ SYMMETRY.

J.Chaventon.

C.R.Acad. Sci. (France), Vol. 253, No. 11, 1199-1201 (Sept. 11, 1961). In French.

The construction of a high-resolution infrared spectrometer is described and some of the results obtained for CH_3CCH and CH_3CN given. W.J.Orville-Thomas

19636 STUDY OF THE INFRARED SPECTRA OF ISOTOPIC OXIDES OF NITROGEN.

R.R.Shvangiradze and Sh.Z.Dzhamagidze.

Optika i Spektrosk. (USSR), Vol. 10, No. 5, 583-8 (May, 1961). In Russian.

The infrared spectra (3-18μ region) of the isotopic molecules $N^{14}O$ and $N^{15}O$, $N^{14}O_2$ and $N^{15}O_2$, and $N_2^{14}O_4$ and $N_2^{15}O_4$ were investigated. The results obtained for the light isotopic forms are compared with the data in the literature. A comparison is made between the experimental frequency ratios of the isotopic molecules and those predicted on the basis of the product rule. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 5, 306-9 (May, 1961)].

19637 VISIBLE SPECTRUM OF AuBa.

J.Schiltz.

C.R. Acad. Sci. (France), Vol. 253, No. 17, 1777-9 (Oct. 23, 1961). In French.

The band spectrum of AuBa, obtained in a King oven, was photographed, and largely classified. For the two principal systems, the lower state is the same. A calculation of the energies of the dissociation products does not enable any identification of this stat to be made. M.R.C.McDowe

19638 STRUCTURE OF THE BAND SPECTRUM OF CuCl MOLECULE. I. ADDITIONAL KNOWLEDGE IN THE COARSE STRUCTURE.

P.Ramakoteswara Rao and J.K.Brody.

J. chem. Phys. (USA), Vol. 35, No. 3, 776-87 (Sept., 1961).

A number of new bands in the A, B, C, D, and E systems of CuCl, recorded in the spectrum of the molecule excited in an electrodeless discharge tube by a microwave oscillator, are reported. Because of the employment of high dispersion and the use of a single isotopic species of CuCl ($Cu^{63}Cl^{35}$), it was possible to investigate the phenomenon of formation of head of heads in the $\Delta v = -4$ sequence of the E system. This phenomenon was also detected in the $\Delta v = -3$ sequence of the A system. The weak F system was photographed for the first time under suitable dispersion so that a satisfactory vibrational analysis of the same could be made. The R heads of this system of the $Cu^{63}Cl^{35}$ molecul are represented by the formula

$$\nu^{F}_{63,35} = 25287.0 + 386.8(v' + \tfrac{1}{2}) - 1.64(v' + \tfrac{1}{2})^2 - 417.1(v'' + \tfrac{1}{2}) + 1.50(v'' + \tfrac{1}{2})^2$$

It is shown that the lower state of the F system is the same as the common lower state of all the other known band systems, which is also the ground state of the molecule. Data on the A and F systems of the $Cu^{65}Cl^{35}$ molecule also are given.

19639 CRYSTAL SPLITTING OF THE ANTHRACENE 3800 A SYSTEM.

T.A.Claxton, D.P.Craig and T.Thirunamachandran.

J. chem. Phys. (USA), Vol. 35, No. 4, 1525-6 (Oct., 1961).

Previous uncertainties in the magnitude of this splitting have been attributed to incomplete polarization of the measuring radiati This is now corrected by the addition of a further polarizing prism and the splittings found agree with the larger of the previous value (see Wolf, Abstr. 5147 of 1959), and with values calculated in the present note. G.F.Lothia

19640 ELECTRONIC SPECTRA OF SUBSTITUTED ANTHRACENES. EVIDENCES FOR APPEARANCE OF THE ^1L_b TRANSITION.

H.Baba and S.Suzuki.

J. chem. Phys. (USA), Vol. 35, No. 4, 1501-2 (Oct., 1961).

In anthracene this transition is hidden under the stronger ^1L_a transition. It was found, however, in a derivative — β-anthrol — from observations of the absorption and fluorescence spectra in iso-octane and aqueous NaOH solutions. G.F.Lothia

19641 INTRAMOLECULAR CHARGE-TRANSFER BANDS OBSERVED IN THE SPECTRA OF SOME ARYL BORO COMPOUNDS.

B.Ramsey, M.A.El-Bayoumi and M.Kasha.

J. chem. Phys. (USA), Vol. 35, No. 4, 1502-3 (Oct., 1961).

Tri-1-naphthylboron has an intense absorption band at λ = 3500 A. This is attributed to excitation of a charge-transfer state in which electrons are transferred to boron from the aromati groups. This is confirmed by the fact that the band disappears when the solution is treated with NH_3, the lone-pair of N occupying the vacant orbital of boron. The position of this band agrees with calculation. G.F.Lothia

19642 TEMPERATURE DEPENDENCE OF THE INTENSITY OF RAMAN SCATTERING LINES IN GASES. I.

L.M.Ovander.

Ukrayin. Fiz. Zh. (USSR), Vol. 5, No. 1, 26-33 (1960). In Ukrainia

Deviations from the usual formula for the temperature dependence were investigated. These deviations may arise on taki into consideration the presence of anharmonism of vibrations, the approach of the incident light frequency to the absorption band, and changes in the frequency of vibrations on passing to the excited electron state. The effect proved to be greater when the frequenc of the incident light gets into the absorption band, and during chang in the frequency of vibrations.

19643 ULTRAVIOLET SPECTRA OF CARBON MONOXIDE.

H.Lefebvre-Brion, C.Moser and R.K.Nesbet.

J. chem. Phys. (USA), Vol. 35, No. 5, 1702-7 (Nov., 1961).

The vertical excitation energies for many of the known electro transitions in carbon monoxide are calculated from LCAO-MO SC ions built on three different basis sets of functions: (a) 1s, 2s, 2p, and 2p' atomic functions on each centre; (b) 1s, 2s, 2p, 3s, 3p atomic functions on each centre; (c) 1s, 2s, 2s', 2p, 2p', 3s, 3p functions on each centre. The excitation energies calculated the functions built on set (a) are hardly different from those ob- ed from an earlier calculation where the SCF orbitals were con- cted from the simplest possible basis set (1s, 2s and 2p functions ach centre). Set (b) gives results which are in quite good agree- t with experiment for all the transitions studied. The calculations ort the analysis made many years ago by Mulliken that the pre- ly known electronic transitions in carbon monoxide can be divided (1) transitions between molecular orbitals both of which are nly made up of atomic L functions; (2) transitions between mole- r orbitals the lower of which is mainly made up atomic L func- s and the upper is mainly atomic M functions. Set (c) gives the energy for the ground state and moderately good agreement with eriment for both kinds of transitions.

19644 UNIVERSAL MOLECULAR INTERACTIONS AND THEIR EFFECT ON THE POSITION OF THE ELECTRONIC ECTRA OF MOLECULES IN TWO-COMPONENT SOLUTIONS. HEORY (LIQUID SOLUTIONS). N.G.Bakhshiev.

ika i Spektrosk. (USSR), Vol. 10, No. 6, 717-26 (June, 1961).
Russian.

Starting from the most general physical considerations, a ple theory was developed describing the effect of universal ermolecular interactions (orientation, induction, and dynamic ects) on the position of the electronic spectra of molecules in -component liquid solutions. Using the Onsager—Böttcher model the structure of solutions, new and simple expressions were nd correlating the magnitude of the spectral shift with physical racteristics of the solvent and the molecules of the solute. The ect of dispersive interactions on the position of the spectra is iewed. [English translation in: Optics and Spectrosc. (USA), . 10, No. 6, 379-83 (June, 1961)].

19645 THE ELECTRONIC STRUCTURES OF NO_2, AND ITS PLANE DIMER N_2O_4. J.Serre.

lecular Phys. (GB), Vol. 4, No. 3, 269-70 (May, 1961).

This paper reports Pariser—Parr type calculations on NO_2 and nar N_2O_4. NO_2 is considered as an eight-electron problem, in ich three electrons are centred on each oxygen atom and two on nitrogen atom. The transition energies from the ground state the first two singlet excited states are in good agreement with periment. N_2O_4 is considered as a fourteen-electron problem, which each oxygen atom contributes three electrons and each rogen atom one. A limited amount of configuration interaction included.

T.E.Peacock

19646 THE THEORY OF π-ELECTRON SYSTEMS. E.Ruch.

Naturforsch. (Germany), Vol. 16a, No. 8, 808-15 (Aug., 1961).
German.

The Rydberg spectra and Scheibe states of π-electron systems re discussed using von Hartmann's refinement of the Huckel theory. comparison of the results with experiment is made.

T.E.Peacock

19647 THE CHEMICAL BOND IN MOLECULAR QUANTUM MECHANICS. T.L.Allen and H.Shull.

. chem. Phys. (USA), Vol. 35, No. 5, 1644-51 (Nov., 1961).

It is postulated that a properly antisymmetrical product function ver geminals (electron-pair wave-functions) is adequate for discussion of the principal chemical properties of molecules. By application of the virial theorem it is shown that such a wave-function as both of the properties essential to the bond-energy concept; amely (a) the energy of a molecule is the sum of the energies of its ndividual bonds and (b) the bond energies are invariant from one olecule to another. Within the framework of this approximation, ond energies, become identified in magnitude with the kinetic energies associated with the respective geminals. The concepts are ufficiently general to include both localized and nonlocalized bonds, nshared electron pairs, odd electrons, and states of various multilicities.

19648 CUBOCTAHEDRAL BONDING. J.R.Canon and G.H.Duffey.

. chem. Phys. (USA), Vol. 35, No. 5, 1657-60 (Nov., 1961).

Molecular orbitals belonging to the different irreducible representations of a B_{12} cuboctahedron are set up and parametric expressions for the energy levels obtained. Terms neglected by Lipscomb and Britton are included. Directed orbitals for group O_h coordination of 12 ligands about a central atom are formulated and Pauling strengths calculated.

19649 ATOMIC ORBITALS WITH ANGULARLY DEPENDENT Z_{eff} TO BE USED IN MOLECULAR ORBITALS CALCULATIONS. E.Scrocco and J.Tomasi.

Molecular Phys. (GB), Vol. 4, No. 3, 193-7 (May, 1961).

A new type of atomic orbital is proposed for use in molecular problems of quantum mechanics. This orbital is formally similar to Slater's orbitals but is characterized by an effective nuclear charge Z_{eff} which is an explicit function of the angles θ and ϕ. The fundamental state of the molecule H_2^+ is studied using such an orbital.

19650 MOLECULAR TWO-CENTRE INTEGRALS BETWEEN 2 pπ AND 3 pπ ATOMIC ORBITALS. III. PENETRATION INTEGRALS. A.Lofthus.

Molecular Phys. (GB), Vol. 4, No. 3, 209-13 (May, 1961).

For Pt II, see Abstr. 14069 of 1961. The evaluation of two-centre Coulomb-penetration and exchange-penetration integrals is discussed. All possible penetration integrals between 2 pπ and 3 pπ atomic orbitals exponent α are reduced analytically and tabulated for α = 1.00 (0.25) 10.00.

19651 A HYDRODYNAMIC MODEL FOR DIAMAGNETIC INDUCED CURRENTS IN MOLECULES. A.D.McLachlan and M.R.Baker.

Molecular Phys. (GB), Vol. 4, No. 3, 255-63 (May, 1961).

The current set up when a single bound electron moves in a magnetic field obeys simple hydrodynamic equations, which arise from a variational principle. When the ground state is not degenerate they have a unique solution, determined by the unperturbed electron density. The theory is closely related to Wick's irrotational flow model for the currents in a rotating molecule,to Tillieu and Guy's variational method, and London and Rebane's ideas of gauge invariance. Difficulties arise when there is more than one electron, when the wave-function has nodes, or when it is degenerate; but the method may be useful for calculating magnetic properties of some small molecules.

19652 THE WAVE FUNCTIONS OF ELECTRONICALLY DEGENERATE STATES. A.D.McLachlan.

Molecular Phys. (GB), Vol. 4, No. 5, 417-23 (Sept., 1961).

The dynamical coupling of nuclear and electronic motions in a degenerate electronic state is described by a complicated vibronic wave-equation, because the adiabatic electronic functions vary rapidly during the vibrations. Hobey and McLachlan (Abstr. 2337 of 1961) tried to show how special linear combinations of the electronic wave-functions could be found, which vary slowly, and lead to a simpler wave-equation. This paper points out a mistake in their argument, but corrects it, and shows that the simple wave-equation is still justified. The new method is similar to Van Vleck's transformation in degenerate perturbation theory, and also applies to molecules which are almost degenerate.

19653 COULOMB AND EXCHANGE INTEGRALS IN THE METHOD OF MOLECULAR STATES. H.Preuss.

Z. Naturforsch. (Germany), Vol. 16a, No. 8, 800-7 (Aug., 1961).
In German.

Starting from the Hartree equation for a molecule an explicit form is developed for the effective one-particle potential appearing in the method of molecular states. In this way it is possible to calculate by a simple self-consistent field method, without empirical additions, the integrals occurring in the extended Hückel method (Abstr. 2340 of 1961). Slater functions are used as atomic wave-functions. The resulting equations for the potential, and the integrals, are valid also for hetero-atomic binding with π-electron systems. A wider definition of charge density and bond order is obtained by the consideration of higher atomic states.

R.G.C.Arridge

19654 A THEORETICAL STUDY OF THE H_3O^+ ION. R.Grahn.

Ark. Fys. (Sweden), Vol. 19, Paper 12, 147-61 (1961).

A survey of experimentally known facts is given. The electronic structure of the H_3O^+ ion was studied by the LCAO MO method. Three different values of the H—O—H angle are considered and the equilibrium angle, which is not known experimentally, is discussed. The results give a slight preference to a value of the H—O—H angle just in the neighbourhood of 120°, i.e. a very flat molecule ion. The proton affinity of the water molecule is obtained, in satisfactory agreement with the experimental value. Population analysis and transformation to two different sets of equivalent orbitals are made.

19655 DOUBLE-ζ SCF MO CALCULATION OF THE GROUND AND SOME EXCITED STATES OF N_2.

J.W.Richardson.
J. chem. Phys. (USA), Vol. 35, No. 5, 1829-39 (Nov., 1961).

Self-consistent field wave-functions for the ground and certain ionized and excited states of the nitrogen molecule, evaluated at the ground state internuclear distance, 1.094 A, are obtained in the molecular orbital (MO) form. The MO's are represented in the usual linear combination of atomic orbitals (LCAO-MO) form, but an expanded basis set is used which contains two each of 2s, 2pσ, 2pπ, and 2p$\bar{\pi}$ Slater-type atomic orbitals of differing nuclear charges. All electronic interactions are properly included and calculated without approximation. The computed total energy of the ground state is −108.785 a.u., which is 21.8 eV above the experimental value but 5.8 eV better than a previous result in which strictly atomic (Slater) orbitals were used in the conventional LCAO form. Excitation and ionization energies obtained by direct calculation of the respective states involved are in reasonably good agreement with experiment, though no better than those same quantities calculated from ground-state orbitals in the usual manner. The wave-functions for the various states are analysed and implications drawn regarding the changes wrought in atomic orbitals by bond formation; relevance to the semiempirical interpretation of quadrupole coupling constants is emphasized. Some conjecture about the correlation energy suggests that the ground-state energy obtained may be only a few electron volts above the true molecular Hartree—Fock energy.

19656 STRENGTH OF THE N—F BONDS IN NF_3 AND OF N—F AND N—N BONDS IN N_2F_4.

A.Kennedy and C.B.Colburn.
J. chem. Phys. (USA), Vol. 35, No. 5, 1892-3 (Nov., 1961).

The heat of formation of the difluoroamino free radical is found to be 8.9 ± 2.5 kcal/mole. The NF_2—F bond in NF_3 is the weakest bond in NF_3 in contrast to ammonia where the NH_2—H bond is the strongest bond. The strength of the NF_2—F bond is 57.1 ± 2.5 kcal/mole while the average NF bond strength in NF_2 and N_2F_4 is 71 kcal/mole. The strength of the N—N bond in tetrafluorohydrazine, as determined from appearance potential data, is 20.7 kcal in excellent agreement with the value 19.8 kcal found by thermal measurements.

19657 CALCULATION OF THE PRINCIPAL MAGNETIC SUSCEPTIBILITIES OF THE BENZENE MOLECULE.

J.Baudet, J.Guy and J.Tillieu.
J. Phys. Radium (France), Vol. 21, No. 7, 600-8 (July, 1960).
In French.

The approximation method previously used by the authors for non-aromatic molecules is applied to benzene. Good agreement is obtained between theoretical values and measurements made for a field perpendicular to the plane of the molecule, but there is less agreement for the other principal susceptibility.

19658 CALCULATIONS OF THE LOWER EXCITED ENERGY LEVELS OF THE CYCLIC POLYENES, RADICALS, AND IONS.

N.Bouman.
J. chem. Phys. (USA), Vol. 35, No. 5, 1661-4 (Nov., 1961).

The lower excited energy levels of the cyclic polyenes, radicals, and ions with 3 to 8 carbon atoms are calculated with inclusion of all the interelectronic integrals and without empirical data, except the carbon—carbon distance.

19659 A ONE-CENTRE S.C.F. WAVE FUNCTION FOR THE METHANE MOLECULE.

E.L.Albasiny and J.R.A.Cooper.
Molecular Phys. (GB), Vol. 4, No. 5, 353-68 (Sept., 1961).

A Hartree—Fock single-determinant wave-function is calculated for the ground state of the methane molecule. The one-electron molecular orbitals in this determinant are expanded up to third-order terms as a series of spherical harmonics about the central carbon nucleus. The potential field due to the nuclei is correspondingly expanded up to sixth-order terms and the complete Hartree—Fock S.C.F. equations are set up and solved numerically for the six radial functions occurring in the molecular orbitals. The numerical techniques employed differ in certain respects from those used in previous atomic calculations. The total molecular energy obtaine from this approximation is −39.90 A.U. The spherically symmetr model, in which only the first term in each expansion is retained, re-examined to settle an uncertainty in the associated energy valu this energy value is here found to be −39.53 A.U.

19660 THEORY OF THE SPIN AND CHARGE DISTRIBUTION IN AROMATIC ION RADICALS; APPLICATION TO TH NAPHTHALENE NEGATIVE ION.

J.C.Schug, T.H.Brown and M.Karplus.
J. chem. Phys. (USA), Vol. 35, No. 5, 1873-83 (Nov., 1961).

The valence-bond method is extended to positive- and negativ ion radicals. General formulae for the required energy, overlap, spin-density, and charge-density matrices are developed and spec ized to pi-electron systems. An application of the method to the p electrons of the naphthalene negative ion is given. Included in the calculation are all unexcited structures with the negative charge i each of the ten possible positions. When approximate exchange ar transfer integrals are used to determine the coefficients of valenc bond structures, the α to β position spin-density ratio is found t be equal to 2.60, in good agreement with the "experimental" value 2.65. The magnitudes of the calculated spin densities are such th a Q of −26.3 gauss is required to obtain the measured hyperfine splittings. To test the validity of these valence-bond results, thei sensitivity to the molecular integral values is examined. Also, co parisons with a variety of molecular-orbital calculations are give It is of considerable interest that the charge distributions obtaine from the valence-bond theory and the molecular-orbital theory ar very different in spite of the similarity of the spin distributions calculated by the two methods.

19661 PROTON RADIO-FREQUENCY SPECTRUM OF HCl^{35}.

J.A.Leavitt, M.R.Baker, H.M.Nelson and N.F.Ramsey
Phys. Rev. (USA), Vol. 124, No. 5, 1482-6 (Dec. 1, 1961).

The r.f. spectrum corresponding to reorientation of the prot magnetic moment in HCl^{35} in the presence of an external magneti field was obtained using the molecular beam magnetic resonance method. From the observed resonance shapes and positions, the value of the spin rotational constant of the proton in HCl^{35} was determined to be $|c_p| = 41 \pm 3$ kc/s. Due to the large quadrupole interaction in HCl^{35}, the perturbation methods of data analysis us with the HF molecule were inapplicable. An approximate theory the proton spectrum was developed in detail to aid in the analysis the experimental data in this case and in cases of similar intermediate coupling. Theoretical spectra were calculated on the Uni computer using this approximate theory and directly compared wi the experimental spectrum to estimate the value of $|c_p|$. Theoretical spectra were also calculated on the Univac using a direct solution of the Hamiltonian secular equation and were compared with the experimental curves to provide a check on the validity of the approximate theory. The comparisons indicate tha the use of the approximate theory will allow the determination of $|c_p|$ to within 10%.

19662 ANALYSIS OF COMPLEX N.M.R. SPECTRA; EPICHLOROHYDRIN.

C.A.Reilly and J.D.Swalen.
J. chem. Phys. (USA), Vol. 35, No. 4, 1522-3 (Oct., 1961).

The spin—spin coupling constants and the chemical shifts for all five protons in epichlorohydrin are derived from the observed n.m.r. spectra at 40 and 60 Mc/s using an interative procedure previously described by the authors (Abstr. 11539 of 1960).

E.F.W.Seymo

19663 CARBON-13 HYPERFINE SPLITTING IN THE ELECTRON SPIN RESONANCE SPECTRA OF SEMIQUINON AND CYCLOOCTATETRAENE.

H.L.Strauss and G.K.Fraenkel.
J. chem. Phys. (USA), Vol. 35, No. 5, 1738-50 (Nov., 1961).

Measurements were made on the C^{13} hyperfine splitting in the ESR spectra of a series of methyl- and chloro-substituted semiquinones and of the cyclooctatetraene anion radical. The splitting were observed from C^{13} nuclei present in natural abundance (appr 1%), and the C^{13} satellites were distinguished from spurious low-intensity lines arising from side-reaction produced radical impurities by means of careful intensity measurements as well as other techniques. The largest observed C^{13} splitting had a magnitude of 1.7 gauss, and in most spectra smaller splittings were found. Th C^{13} satellites were overlapped by the major lines in the spectra (arising from proton splitting), but after correcting the measured intensities for this overlap, good agreement was found between th predicted and measured intensities in those spectra in which a de ed analysis was possible. In the p-benzosemiquinone ion, a pre- usly observed line of low intensity has been identified as a tting arising from C^{13} nuclei, and has been assigned, on the basis ntensity measurements, to the four CH carbon atoms. No tting was found from the carbon atoms in the CO bonds of this npound, and it was concluded that the splitting is less than 0.6 ss. Splitting constants tentatively identified with the methyl bon atoms of the methyl-substituted compounds were in the neigh- rhood of 1.5 gauss. The splitting in the cyclooctatetraene anion icates that the three sigma bonds attached to a carbon atom lie in ingle plane. The experimental results are in agreement with the ory of C^{13} hyperfine splittings recently developed by Karplus and aenkel. Comparison of theory and experiment indicates that these sults provide a very sensitive measure of the pi-electron spin den- ies in the radicals. The valence-bond theory of the spin-densities the methyl substituents is shown to be inadequate in its present m, but the molecular-orbital theory appears to give good agree- nt. This latter agreement is based on certain as yet unjustified sumptions, and therefore both theories require re-examination. e spectrum of the previously observed semiquinone ion formed om 2,5-dihydroxyquinone was interpreted in order to obtain an timate, in conjunction with other data, of the hyperfine splitting at C^{13} nucleus of the carbon atom in a CO band. The analysis also ows that the two CH carbon atoms in this compound have negative -electron spin densities.

19664 LOW TEMPERATURE PARAMAGNETIC RESONANCE OF TRAPPED O_2.

S.Foner, H.Meyer and W.H.Kleiner.

Phys. Chem. Solids (GB), Vol. 18, No. 4, 273-85 (March, 1961).

Low temperature paramagnetic resonance experiments of ygen molecules trapped in single-crystal β-quinol clathrate are scribed. The large zero-field splitting of the trapped O_2 dictated e of high fields and high frequencies. Measurements with d.c. d pulsed magnetic fields, and 4 and 8 mm wavelength radiation ere therefore employed for the experiments with various fractions of the β-quinol cages occupied by molecules. The results are terpreted in terms of the hindered rotation theory applied by eyer et al. to magnetic sysceptibility measurements. The trigonal is was identified as the axis of minimum energy, and the zero- eld splitting was measured to be about 4.4°K, in reasonable agree- ent with the value derived from magnetic susceptibility measure- ents. The paramagnetic resonance on samples with $p > \sim 0.2$ owed a complex structure composed of several lines which tended over a range of 2 kg, and could be resolved at 1.5°K. xperiments with dilute systems of O_2 in N_2 clathrate crystals $_{O_2} < 0.05$) showed three well resolved component lines corres- nding to zero-field splittings D', D'_0, D'_2 with $D'_0/k = 4.36 \pm 0.05°K$, $)' - D'_0)/k = 0.127 \pm 0.01°K$, and $(D'_2 - D'_1)/k = 0.094 \pm 0.01°K$. The elative intensities of the components can be interpreted quantitatively s a function of p by associating the three zero-field splittings with ccupation of the two cages nearest to a resonating molecule by ero, one, or two molecules, respectively. The change in hind- ance potential due to van der Waals forces between the O_2 and its earest N_2 neighbours is calculated, and the resulting zero-field plitting changes are compared with those derived from the reson- nce spectrum. An upper limit for the paramagnetic spin—lattice elaxation time of O_2 in β-quinol, $T_1 \leq 50$ μsec at 1.5°K, was stimated from the pulsed field resonance data.

19665 DETERMINATION OF THE RELATIVE SIGNS OF PROTON SPIN COUPLING CONSTANTS BY DOUBLE RRADIATION.

R.Freeman and D.H.Whiffen.

lolecular Phys. (GB), Vol. 4, No. 4, 321-5 (July, 1961).

The method of Evans [Proceedings of the Chemical Society GB), 1961, p. 208] for determining relative signs of nuclear spin oupling constants by doubel irradiation experiments is extended o the case where the three coupled nuclei are all protons. It is hus possible to demonstrate from the high resolution proton agnetic resonance spectrum of the ring protons of 2-furoic cid that the three spin coupling constants are all of like sign.

19666 THE RELATIVE SIGNS OF N.M.R. SPIN COUPLING CONSTANTS FROM DOUBLE IRRADIATION XPERIMENTS.

R.Freeman.

lolecular Phys. (GB), Vol. 4, No. 5, 385-93 (Sept., 1961).

The method of double irradiation in high resolution proton agnetic resonance was used to confirm that the spin coupling onstant between the methyl group and the proton in the cis position both trans-crotonaldehyde and trans-crotonic acid differs in sign rom the other coupling constants. Since this is a particularly searching test of the double irradiation method, it is suggested that relative signs of coupling constants could be determined in this way for most molecules containing three coupled hydrogen nuclei provided that the chemical shifts are large compared with the coupling constants.

19667 NUCLEAR MAGNETIC RESONANCE SPECTRA FOR A SYSTEM ABC OF SPIN $\frac{1}{2}$ NUCLEI AND THEIR LINEWIDTHS.

S.S.Jha.

Proc. Indian Acad. Sci. A, Vol. 54, No. 1, 13-23 (July, 1961).

The exact solution is obtained for the intensities and frequençies of the 15 components of the spectrum of such a system, for arbitrary values of the ratios of spin—spin couplings to relative chemical shifts. An outline of the calculation of the line-widths of the components, starting from the general expressions of Bloch (Abstr. 6079 of 1956), is also presented. E.F.W.Seymour

19688 PROTON RESONANCE SHIFTS AND ELECTRON SUSCEPTIBILITIES IN 1, 3-BISDIPHENYLENE 2-PHENYL ALLYL.

M.E.Anderson, R.S.Rhodes and G.E.Pake.

J. chem. Phys. (USA), Vol. 35, No. 4, 1527-8 (Oct., 1961).

The shift of the resonance due to eight of the protons in the polycrystalline free radical is interpreted in terms of an exchange-averaged hyperfine interaction. The hyperfine field is opposed to the applied field since the shift is to higher applied fields. The temperature dependence of the shift yields that of the electron susceptibility and also the magnitude of the hyperfine coupling constant, which is found to be 3·7 ± 0·5 Mc/s. E.F.W.Seymour

19669 LONG-RANGE N^{14}—H^1 NUCLEAR-RESONANCE COUPLING IN ISONITRILES.

I.D.Kuntz, Jr., P.von R.Schleyer and A.Allerhand.

J. chem. Phys. (USA), Vol. 35, No. 4, 1533-4 (Oct., 1961).

Triplets of relative intensity 1:1:1 were observed in the proton magnetic resonance of five isonitriles due to N^{14}—H^1 spin—spin coupling. The fact that splittings were observable means that the electric field gradients at the N^{14} nuclei in isonitriles must be much less than in the many other nitrogen-containing compounds which showed no such splittings. E.F.W.Seymour

19670 METALLIC NATURE OF THE STARCH-IODINE COMPLEX.

R.Bersohn and I.Isenberg.

J. chem. Phys. (USA), Vol. 35, No. 5, 1640-3 (Nov., 1961).

A weak electron resonance was observed in the amylose-iodine complex. It is shown that if the iodine atoms in each chain are covalently bonded to each other, the band of the 5pσ states is only partially filled. Hence the row of atoms will have metallic properties including weak paramagnetism and electronic conductivity.

19671 THERMAL DISSOCIATION RATE OF HYDROGEN.

W.C.Gardiner, Jr and G.B.Kistiakowsky.

J. chem. Phys. (USA), Vol. 35, No. 5, 1765-70 (Nov., 1961).

The thermal dissociation rate of hydrogen in xenon—hydrogen mixtures was studied with shock-wave techniques over the temperature range 3000°-4500°K. The observed density profiles were consistent with the rate constant expressions:

$$
\begin{array}{ll}
H_2 + Xe = Xe + 2H & k = 1.8 \times 10^{17} T^{-1/2} \exp(-D/RT) \mathrm{cm}^3 \mathrm{mole}^{-1} \sec^{-1} \\
H_2 + H_2 = H_2 + 2H & k = 1.8 \times 10^{20} T^{-3/2} \exp(-D/RT) \mathrm{cm}^3 \mathrm{mole}^{-1} \sec^{-1} \\
H_2 + H = 3H & k = 1.2 \times 10^{18} T^{-1/2} \exp(-D/RT) \mathrm{cm}^3 \mathrm{mole}^{-1} \sec^{-1}.
\end{array}
$$

19672 MASS SPECTROMETRIC STUDIES OF EVAPORATION PHENOMENA OF SOME COMPOUNDS WITH ZINC BLENDE STRUCTURE IN THE TEMPERATURE REGION AROUND 1000°K.

H.Gutbier.

Z. Naturforsch. (Germany), Vol. 16a, No. 3, 268-79 (March, 1961). In German.

Mass spectroscopic studies of the constituents which evaporate near 1000°K from InP, InSb, GaAs, In $(P_{0.56} As_{0.44})$ and $ZnSnAs_2$ showed that the compounds disintegrate and that the group V components evaporate as four- and two-atom molecules. Evaporation of In $(P_{0.56} As_{0.44})$ yields molecules of all possible combinations between P and As atoms. No radicals were observed which contain atoms from both groups III and V. The appearance potentials of the ions were measured as well as the enthalpies of formation of the different evaporation processes (from the temperature dependence of the evaporation rates). It was found that Pauling's method for calculating the enthalpies of formation with the electronegativity of the elements leads to useful results.

G.K.Wehner

19673 ELECTRON SPIN RESONANCE STUDIES OF RADICALS FORMED IN IRRADIATED POLYTETRAFLUOROETHYLENE.

T.Matsugashita and K.Shinohara.

J chem. Phys. (USA), Vol. 35, No. 5, 1652-6 (Nov., 1961).

Radicals formed in irradiated PTFE were studied by means of e.s.r. using reactions with gases. In interpreting the experimental results, it was assumed that the radicals formed in PTFE primarily by irradiation were $-CF_2-CF-CF_2-$ and $-CF_2-CF_2$. The former were found to be stable, but the latter to be very reactive, at room temperature. A large part of the latter is thought to disappear by recombination, and only a small part to be oxidized by oxygen occluded in the polymer to form less reactive oxide radicals $-CF_2-CF_2-O\cdot$ even in a vacuum vessel. The radicals $-CF_2-CF-CF_2-$ give a double quintet and $-CF_2-CF_2-O\cdot$, a triplet in the spectrum. When gaseous oxygen was admitted to the irradiated PTFE, oxygenated radicals were formed. They are $-CF_2-(CF-OO\cdot)-CF_2-$ and $-CF_2-CF_2-OO\cdot$; the former giving asymmetrical signal termed O_I, and the latter a singlet O_{II}. The following reversible reactions were also studied: $-CF_2-CF-CF_2- + O_2 \rightleftharpoons -CF_2-(CF-OO\cdot)-CF_2-$, and $-CF_2-CF-CF_2- + NO \rightleftharpoons CF_2-(CF-NO)-CF_2$. Some discussions are given on the reactions between irradiated PTFE and gases.

19674 "ROTATIONAL" ISOMERS OF CYCLOPENTANE DERIVATIVES.

K.Kozima and W.Suëtaka.

J. chem. Phys. (USA), Vol. 35, No. 4, 1516-17 (Oct., 1961).

Spectroscopic evidence is provided for the existence of rotational isomers of cyclopentane derivatives and an energy difference of 0.87 kcal/mole found for liquid 1,1,2-trichlorocyclopentane.

W.J.Orville-Thomas

19675 ENERGY TRANSFER IN POLYATOMIC MOLECULES. I. CATALYSIS OF ENERGY TRANSFER WITH ISOTOPIC MOLECULES.

G.H.Hudson, J.C.McCoubrey and A.R.Ubbelohde.

Proc. Roy. Soc. A (GB), Vol. 264, No. 1318, 289-98 (1961).

The dispersion of sound was compared for ethylene and tetradeutero-ethylene. Relaxation times of 0.26 and 0.14 μsec for these molecules follow the general trend with molecular frequencies predicted by theory. A quantitative account of the observed ratio 1 : 2 of relaxation times can best be given by introducing the notion of "complex collisions" and by abandoning the concept that the rate of activation of the lowest vibrational mode fully controls the rate of activation of higher modes. Small amounts of C_2D_4 or $C_2D_2H_2$ act as energy transfer catalysts for ethylene. Both H_2O and D_2O likewise act as catalysts, approximately to the same extent. Theoretical interpretations of these findings are discussed.

19676 ENERGY TRANSFER IN POLYATOMIC MOLECULES. II. RELATIVE CATALYTIC EFFICIENCY FOR ENERGY TRANSFER TO DIFFERENT VIBRATIONS TO THE SAME MOLECULE.

J.C.McCoubrey, R.C.Milward and A.R.Ubbelohde.

Proc. Roy. Soc. A (GB), Vol. 264, No. 1318, 299-308 (1961).

Vibrations of sulphur dioxide show two separate relaxation times. Values of $\tau_1 = 6.0 \times 10^{-8}$ sec for the vibrations of 519 cm^{-1} and $\tau_2 = 1.2 \times 10^{-6}$ sec for the vibrations of 1151 and 1361 cm^{-1} were derived from ultrasonic measurements, in fair agreement with earlier work. Molecules studied as possible vibration--translation catalysts included ethane, ethylene, water, and n-hexane. No enhanced efficiency of energy transfer was observed with ethylene. Ethane and water molecules were found to be only moderately efficient catalysts; proportionally, they exert a greater effect for processes associated with τ_1. Deuterium oxide is found to be somewhat more efficient than water. n-Hexane is highly efficient for both the τ_1 and τ_2 relaxation processes of sulphur dioxide. These observations are discussed in relation to various mechanisms for the catalysis of energy transfer.

19677 THE FORCES BETWEEN POLYATOMIC MOLECULES. II. SHORT-RANGE REPULSIVE FORCES.

L.Salem.

Proc. Roy. Soc. A (GB), Vol. 264, No. 1318, 379-91 (1961).

For Pt I, see Abstr. 14132 of 1961. The Hellmann--Feynman theorem is used to examine the qualitative behaviour of short-range repulsive forces between closed-shell polyatomic molecules whose electron clouds overlap slightly. It is found that the most importan contribution to the repulsive forces arises from a reduction in combined electron density in the region of overlap. Using this result it is possible to show that for two molecules whose electron density is best described by localized orbitals, and for which the orbitals of one molecule do not overlap the orbitals of the other in more than one localized interatomic region, the forces are locally additive over pairs of atoms, one in each of the interacting molecul However, those molecules which are adequately described by orbit which extend over the molecular frame-work and which can overlap opposite orbitals in more than one interatomic region, will not interact in a locally additive way.

19678 CORRECTION TO AN ARTICLE ON THE STATISTICAL MECHANICS OF CHAIN MACROMOLECULES IN A VELOCITY FIELD.

R.Koyama and R.Cerf.

J. Phys. Radium (France), Vol. 21, No. 5, 503-4 (May, 1960).
In French.

See Abstr. 15793 of 1960. Corrected equations are deduced for the case where the solution of macromolecules has a very high internal viscosity.

G.I.W.Llewely

19679 METHOD OF OBTAINING MOLECULAR BEAMS OF VERY HIGH VELOCITY.

M.Devienne.

C.R. Acad. Sci. (France), Vol. 253, No. 17, 1750-1 (Oct. 23, 1961).
In French.

It is suggested that a beam of fast neutral atoms or molecules may be obtained via resonant charge exchange of a hypersonic beam of neutrals with a beam of fast singly charged ions of the same species, in a collision region at pressures of the order of 10^{-3} microns. A crossed beam apparatus was constructed and is to be described in a forthcoming note.

M.R.C.McDowel

19680 COLLISION MECHANICS IN CROSSED MAXWELLIAN MOLECULAR BEAMS.

S.Datz, D.R.Herschbach and E.H.Taylor.

J. chem. Phys. (USA), Vol. 35, No. 5, 1549-59 (Nov., 1961).

A general treatment of the mechanics of collision between two Maxwellian molecular beams is described. Expressions are obtain for the distribution in collision energy, for the elastic and reactive collision rates, and for the angular distribution of the centre of mas vectors for beams colliding at any angle. The treatment can accom modate any reaction cross-section which can be expressed as a ste function multiplied by a linear combination of powers of the relative energy. The recoil momentum which affects the product distributio in the laboratory system is discussed, and the treatment is applied to some experimental data on the reaction of K with HBr.

19681 COHERENT AND INCOHERENT SCATTERING OF X-RAYS BY H_2 AND He.

G.E.Kilby.

Proc. Phys. Soc. (GB), Vol. 78, Pt 5(i), 673-80 (Nov., 1961).

An electron density map calculated by Rollett from an accurate function of James and Coolidge was used to obtain the coherent X-ray scattering from molecular hydrogen. The results given by the Coulson self-consistent field function are also presented, and it is shown that there is excellent agreement with the James—Coolidge results and with earlier calculations of Carter, March and Vincent (Abstr. 1085 of 1958). In addition a more careful study of the incoherent scattering was made than had previously been attempted. By considering two correlated wave functions, that of Eckart and Hylleraas for helium and that of Gurnee and Magee for hydrogen, previous approximations are shown to lead to somewhat high estimates of the total scattered intensity. For hydrogen, a maximum reduction of about 4% brings theoretical results to withi 1% of the experimental values of Wollan (1931). The momentum distribution and the corresponding shapes of the Compton lines were also considered for hydrogen and helium. It is suggested fro the results obtained for molecular hydrogen that more accurate measurements of the Compton profile might afford a useful method of studying bonding electrons.

SOLID-STATE PHYSICS

19682 THE THEORY OF A CRYSTAL.
I.P.Bazarov.

kl. Akad. Nauk SSSR, Vol. 140, No. 1, 85-7 (Sept. 1, 1961). Russian.

Gives a derivation of the self-consistent field equation from Hamiltonian. [English translation in: Soviet Physics—Doklady A)]. R.F.S.Hearmon

19683 "EFFECTIVE" IONIC CHARGE IN CRYSTALS.
W.Cochran.

ture (GB), Vol. 191, 60-1 (July 1, 1961).

There is much confusion as to the definition of effective ionic arge as a measureable quantity. Methods of estimation (X-ray fraction, "lattice dynamical", and other miscellaneous methods) e discussed. (See Abstr. 11111 of 1961). A.R.Stokes

BONDING IN Al_2O_3 AND E.S.R. OF V^{3+} IN CORUNDUM.
e Abstr. 20236

THEORY OF COVALENT BONDING IN THE SALTS OF COBALT.
e Abstr. 20237

19684 THE LATTICE ENERGIES OF OXIDES.
S.M.Ariya and M.S.Soboleva.

z. tverdogo Tela (USSR), Vol. 3, No. 10, 3157-61 (Oct., 1961). Russian.

The lattice energy arises principally from the bond energy particles in direct contact. When considered in this way the ttice contains almost no ions in the usual sense, that is when the ntre of the charge distribution coincides with the centre of its n particle. The lattice energy arising from the presence of some ns seems to be small. [English translation in: Soviet Physics—lid State (USA)]. K.G.Major

19685 A GENERALIZED EWALD METHOD FOR LATTICE SUMS.
S.Adler.

hysica (Netherlands), Vol. 27, No. 12, 1193-1201 (Dec., 1961).

By a simple and straightforward procedure an Ewald method r the lattice sum

$$\sum_{j,k} c_k f(|r_j{}^k|)[\sum_m A_m Y_{lm}(\theta_j{}^k,\phi_j{}^k)]\, e^{iK.r_j{}^k}$$

derived. The function f is arbitrary, subject only to the con-ition that it be representable by a certain integral transform.

19686 MÖSSBAUER EFFECT OF THE INTERMETALLIC COMPOUND UFe_2.
Komura, N.Kunitomi, P.K.Tseng, N.Shikazono and H.Takekoshi.

Phys. Soc. Japan, Vol. 16, No. 7, 1479 (July, 1961).

The hyperfine field at the position of Fe^{57} nuclei in UFe_2 was und to be 20 ± 8 kOe at room temperature, and 65 ± 8 kOe at quid-nitrogen temperature. The absorption pattern at the lower mperature spreads broadly indicating that the hyperfine field may ke the fluctuating values below 65 kOe. E.A.Sanderson

19687 NUCLEAR SPIN STATES IN MOLECULAR CRYSTALS.
L.B.Borst, S.L.Borst, L.Koysooko, H.Patel and .Stusnick.

hys. Rev. Letters (USA), Vol. 7, No. 9, 343-5 (Nov. 1, 1961).

Ortho- and para-states in solids were studied by means of neutron scattering measurements, the two states differing greatly in scattering cross-section. In solid acetylene, the observed cross-section fell from 140 barns at 77°K to 10 barns below 4°K, on account of predominance of the para-state at low temperatures. Similar experiments with water (ice) showed a substantial transformation from ortho- to para-states at 4°K, with accompanying loss of scattering power, in spite of the presence of hydrogen bonds. Ice was shown to be an ineffective moderator at 4°K, on account of the lack of levels near the ground state of the para-form. Such effects are expected in other solids, and must be taken into account in evaluation of neutron diffraction data. J.Sheridan

QUADRUPOLAR EFFECTS IN ALLOYS. See Abstr. 20630

LATTICE MECHANICS

19688 THE CALCULATION OF THE POLARIZATION ENERGY OF IONIC LATTICES.
T.Neugebauer.

Acta phys. Hungar., Vol. 12, No. 4, 279-89 (1960). In German.

A derivation of the polarization energy is outlined briefly, together with the higher moments. The formulae obtained reduce to a simple form upon the assumption of a product or determinantal wave-function, for spherically symmetric ions. K.G.Major

19689 REMARKS ON THE LATTICE DYNAMICS OF ALKALI HALIDE CRYSTALS.
S.O.Lundqvist.

Ark. Fys. (Sweden), Vol. 19, Paper 10, 113-21 (1961).

In a couple of earlier papers (Abstr. 6332 of 1955; 7479 of 1958) a treatment of the lattice vibrations of the alkali halides was proposed, starting from the Heitler—London approach and supplemented with terms accounting for the dipolar polarization of ions in the lattice. A preliminary calculation along such lines was reported in Abstr. 4261 of 1960. Recently a formally different scheme, the so-called shell model of lattice vibrations, based on a paper by Dick and Overhauser (Abstr. 4542 of 1959) was successfully developed and applied by Cochran (Abstr. 11558 of 1959, 9844 of 1960). The physical assumptions of the original papers are here reconsidered and it is shown that the scheme proposed not in fact restricted to the Heitler—London approximation, and that the physical content of the former scheme and the shell model, although formally quite different, are essentially the same.

19690 THE DYNAMIC THEORY OF IONIC CRYSTALS OF THE NaCl TYPE. THERMAL AND ELASTIC PROPERTIES.
V.V.Mitskevich.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3022-35 (Oct., 1961). In Russian.

A theory of ionic crystals of the NaCl type is presented in which the dynamics of the crystal lattice are included. In the expression for the potential energy second-order terms are included to account for the Van der Waals energy, the interaction of the deformed electron clouds of the ions (in a dipole approximation), and the charge-quadrupole interaction. The elastic constants, the thermal expansion coefficient and the specific heats at high temperature are calculated and the results are compared, for NaCl, with published experimental data. It is found that for the alkali halides the approximation of strong electron binding is satisfactory. See also following abstract. [English translation in: Soviet Physics—Solid State (USA)]. D.A.O'Connor

19691 THE DYNAMIC THEORY OF IONIC CRYSTALS OF THE NaCl TYPE. DIELECTRIC AND OPTICAL PROPERTIES.
V.V.Mitskevich.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3036-45 (Oct., 1961). In Russian.

On the basis of a dynamic theory (see preceding abstract), the dielectric and the optical properties (spectra) in the infrared region, of ionic crystals of the NaCl type are investigated. It is found that for NaCl the theoretical results are in good agreement with published experimental data. [English translation in: Soviet Physics—Solid State (USA)]. D.A.O'Connor

19692 MOTION OF THE AMMONIUM ION IN LATTICES OF THE NaCl TYPE.
W.Vedder and D.F.Hornig.

J. chem. Phys. (USA), Vol. 35, No. 5, 1560-8 (Nov., 1961).

The infrared spectrum of NH_4I in the NaCl-type phase gives insufficient information about the motion of the ammonium ions in that phase. Dilute solutions of NH_4^+ in NaCl-type alkali halides provide considerably more detail in the form of a fine structure in most of the absorption bands which becomes visible on sufficient cooling. This fine structure is most certainly correlated with a rotational motion of the NH_4^+ ion. However, both models suggested in the literature — free rotation and rotation of the ion about a $N\text{-}H\cdots X^-$ axis — deviate in many important respects from the experimental results.

19693 MÖSSBAUER EFFECT MEASUREMENTS ON SUPERCONDUCTING INDIUM.

P.P.Craig, R.D.Taylor and D.E.Nagle.
Nuovo Cimento (Italy), Vol. 22, No. 2, 402-5 (Oct. 16, 1961).

The amplitude and width of the Mössbauer resonance in Fe^{57} was measured for Fe^{57} as a very dilute impurity in metallic In. The resonance amplitude is found to remain substantially unchanged in the temperature interval 0.35°-4°K, showing that the Debye temperature of In increases by less than 3 deg K in this temperature range. Specific heat measurements on In had indicated a possible Debye temperature change of 12 deg K. As the source is cooled from 300° to 4°K the resonance amplitude increases by only 50% in contrast to the minimum of 500% calculated from the Debye—Waller factor.

19694 PRESSURE DEPENDENCE OF THE MÖSSBAUER EFFECT.

R.V.Hanks.
Phys. Rev. (USA), Vol. 124, No. 5, 1319-20 (Dec. 1, 1961).

The pressure dependence is examined and expressions are given (in the Debye approximation) for the probability of recoilless emission (absorption) as a function of the specific volume. It is concluded that the effect of pressure is slight for metals such as Zn, Sn, etc., but that more compressible elements should exhibit observable pressure dependences at moderate pressures. A calculation is given which predicts that the recoilless emission of the 81 keV line in Cs^{133} should become observable at a pressure of about 5000 atm. Some additional experiments involving the above pressure dependence are also discussed.

19695 ON THE PARTICULAR ROLE OF THE OPTICAL BRANCH IN THE MÖSSBAUER EFFECT.

Yu.Kagan.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 659-61 (Aug., 1961). In Russian.

It is shown that analysis of the influence of the optical branch of the phonon spectrum in crystals on the magnitude of the Mössbauer effect may explain the anomalous temperature dependence of the effect recently observed in SnO$_2$ and Dy$_2$O$_3$, in which the size of the effect falls much more slowly with rising temperature than anticipated. [English translation in: Soviet Physics—JETP (USA)]. G.E.Murphy

19696 WIDTH AND SHAPE OF MÖSSBAUER LINES IN SOLID SOLUTIONS.

M.A.Krivoglaz.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 765-72 (Sept., 1961). In Russian.

The Mössbauer effect in solid solutions is studied. The dependence of vibrational energy due to variation of the mass of the absorbing or radiating nucleus on the configuration of various types of atoms surrounding the nucleus is taken into account explicitly. Mössbauer line broadening due to this cause is estimated and the line shape in solid solutions is considered for the extreme cases of a large and small natural width. Other causes of Mössbauer line broadening in solid solutions are indicated. [English translation in: Soviet Physics—JETP (USA)].

19697 ANALYSIS OF THERMAL VIBRATIONS IN CRYSTALS: A WARNING.

K.Lonsdale and J.Milledge.
Acta cryst. (Internat.), Vol. 14, Pt 1, 59-61 (Jan., 1961).

Attention is drawn to the difficulty of obtaining an unambiguous interpretation of the thermal vibration ellipsoids of atoms deduced from X-ray diffraction data; two sets of data for anthracene are used as an illustration. A.R.Stokes

19698 LONG-RANGE FORCES AND THE DYNAMICAL EQUATIONS FOR HOMOPOLAR CRYSTALS OF THE DIAMOND TYPE.

K.B.Tolpÿgo.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 943-56 (March, 1961). In Russian.

Following recent investigations of the dispersion law for lattice vibrations in Ge and Si, the procedure for calculating the potential energy of a crystal lattice, considered previously (Abstr. 5461 of 1958) is re-examined, using more general assumptions; the introduction by Cochran (Abstr. 11558 of 1958) of mixed terms corresponding to the dipole moments of immediate neighbours in the potential energy is justified here. The origin of long-range forces is discussed, and the equations of the Fourier components of the lattice vibrations are deduced. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 685-93 (Sept., 1961)]. G.E.Murphy

19699 NORMAL FREQUENCIES OF VIBRATION OF GERMANIUM LATTICE, CALCULATED IN DIFFEREN APPROXIMATIONS.

Z.A.Demidenko, T.I.Kucher and K.B.Tolpÿgo
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2482-94 (Aug., 1961). In Russian.

The normal frequencies of the germanium lattice are considered in the calculation of electronic dipole moments P_S^l due to displaced nuclei. The internal field matrix is calculated in approximations up to the third order, using the expression for the potential energy U due to Tolpÿgo (see preceding abstract); the results are compared with recent experiments, and with the calculations of Cochran (Abstr. 11558 of 1959). [English translation in: Soviet Physics—Solid State (USA)]. G.E.Murph

19700 OPTICALLY ACTIVE LATTICE VIBRATIONS AS TREATED BY THE GF-MATRIX METHOD.

T.Shimanouchi, M.Tsuboi and T.Miyazawa.
J. chem. Phys. (USA), Vol. 35, No. 5, 1597-1612 (Nov., 1961).

A general description is given of an application of the Wilson's GF-matrix method to the treatment of optically active lattice vibrations. As examples, formulae are derived for the calculation of the frequencies of the lattice vibrations of a one-dimensional, the diamond, and CaF$_2$ lattices.

19701 EVALUATION OF VIBRATION SPECTRUM AND HEAT CAPACITIES OF TUNGSTEN AND MOLYBDENUM BY DE LAUNAY'S ELECTRON GAS MODEL.

B.Sharan.
Phys. Status solidi (Germany), Vol. 1, No. 3, 243-53 (1961).

De Launay's model of electron-lattice interaction was applied to evaluation of the vibration spectrum of two body-centred cubic metals, viz. tungsten and molybdenum. Following Kellermann (194 the reciprocal phase space is divided into 10 × 10 × 10 cells. However, the secular determinant is solved only for 47 points of th first Brillouin zone (including the origin). A correct enumeration, considering the proper statistical weights, yields 3000 frequencies (a point missed by the earlier workers). The calculated specific heats are in very good agreement with experiment. In the case of tungsten the results were compared with those of Fine (1939), who ignored the effect of electrons in the lattice vibrations. It is found that de Launay's model gives a better agreement with observed data than Fine's at all temperatures.

19702 NUCLEAR QUADRUPOLE COUPLING IN ALKALI IODIDE CRYSTALS.

M.Menes and D.I.Bolef.
J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 79-86 (April, 1961).

The dynamic nuclear quadrupole interaction (first derivative o the quadrupole interaction with respect to strain) was measured fo the I^{127} nucleus in crystals of CsI, RbI, KI, and NaI. These measur ments were made by observing the resonant absorption of energy from an acoustic wave by the nuclear spins. Longitudinal waves propagating along a cubic axis of the crystal were used. The observed values of the dynamic nuclear quadrupole interaction are CsI, 1600 Mc/s; RbI, 615 Mc/s; KI, 300 Mc/s; NaI, 660 Mc/s. These values can be correlated with the chemical shift of the iodine ion in these crystals with the help of a simple model. This model, which is based on work of Townes and Dailey and Yosida and Moriya, attributes the quadrupole coupling and the chemical shift to the hole left in the outer p shell of the ion. This hole is due to the distortion of the ion (admixture of excited states) by the crysta surroundings. In connection with this work, the chemical shift of LiI^{127} was measured and found to be -3.3×10^{-4}.

19703 THEORY OF ABSORPTION OF ULTRASOUND BY METALS IN A STRONG MAGNETIC FIELD. II.

É.A.Kaner.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1071-7 (Oct., 1960). In Russian.

For Pt I, see Abstr. 6012 of 1960. The asymptotic absorption of ultrasound by open Fermi surface metals located in a strong magnetic field is investigated. It is shown that the deformation absorption coeff cient becomes saturated irrespective of the presence of open trajectories. A pronounced anisotropy of the saturation exists, depending on position of the sound wave vector relative to the magnetic field and the direction of the open trajectory. Peculiarities of inductive absorption of ultrasound are studied in the case of open Fermi surfaces. The asymptotic value of the conductivity tensor in a magnet field is computed by taking into account space dispersion. [Englisl translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 747-5 (April, 1960)].

19704 SOUND ABSORPTION IN ROCHELLE SALT CLOSE TO ITS LOWER CURIE POINT.

.Shustin, T.S.Velichkina, K.N.Baranskii and I.A.Yakovlev.
eksper. teor. Fiz. (USSR), Vol. 40, No. 3, 979-80 (March, 1961).
ussian.

A high absorption of 5 Mc/s waves is found at -18°C associated h a relaxation process due to the re-establishment of equilibrium a crystal undergoing a second-order phase transition. Excellent eement with a theory of Landau is obtained. [English translation Soviet Physics—JETP (USA), Vol. 13, No. 3, 683-4 (Sept., 1961)].
C.A.Hogarth

19705 QUANTUM THEORY OF SOUND ABSORPTION BY METALS IN A MAGNETIC FIELD. V.G.Skobov.

eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1446-51 (May, 1961).
ussian.

The effect of electron scattering on absorption of sound by tals in strong magnetic fields is studied for the case of large tial dispersion. The case when electron scattering is caused their interaction with neutral impurities is considered. [English nslation in: Soviet Physics—JETP (USA)].

MAGNETOACOUSTIC EFFECTS AND THE FERMI SURFACE METALS. See Abstr. 19739-42

ULTRASONIC ABSORPTION IN FAST NEUTRON IRRADIATED)$_2$ GLASS. See Abstr. 20634

19706 INELASTIC MAGNETIC SCATTERING OF SLOW NEUTRONS BY PHONONS. B.M.Khabibullin.

. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1027-30 (Oct., 1960).
Russian.

An estimate is made of the differential cross-section for in- astic scattering of neutrons by phonons due to magnetic interaction the neutrons with the spin system of a paramagnet. A value /dΩ = 10^{-27} cm^2 is obtained for the cross-section. [English trans- ion in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 714-16 pril, 1961)].

19707 ELASTIC RESONANCE SCATTERING OF SLOW NEUTRONS IN CRYSTALS.

V.Kazarnovskii and A.V.Stepanov.
. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1039-41 (Oct.,1961).
Russian.

Formulae are derived for the differential cross-section for astic resonance scattering of slow neutrons in crystals. The pressions obtained are evaluated in the Debye approximation. nglish translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 3-4 (April, 1961)].

19708 STUDY OF THE SCATTERING CROSS-SECTION IN ICE FOR VERY SLOW NEUTRONS AT 4°K.

.Springer and W.Wiedemann.
. Phys. (Germany), Vol. 164, No. 1, 111-19 (1961). In German.

Transmission experiments with neutrons in the range of 5 × 10^{-4} to 3 × 10^{-3} eV energy enabled determination of the ainly incoherent scattering cross-section σ_s in ice at 4°K. The ean zero point oscillation amplitude of the protons was computed om the energy function $\sigma_s(E)$ after first neglecting the contri- ution of inelastic scattering processes to σ_s, and the experimental urve of $\sigma_s(E)$ was found to be in good agreement with that computed eoretically. The mean amplitude (experimentally determined) of .19 A agrees, within the computation and measurement error of 0% each, with the computed value. The results justify the ssumption that no strongly populated low energy levels are resent and corroborate a simplified oscillation spectrum uggested.
L.Mordecai

19709 INVESTIGATION OF TWO-PHONON PROCESSES USING THE DENSITY MATRIX METHOD. I.G.Lang.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2573-88 (Sept., 1961).
n Russian.

The correction to the electron mobility in atomic crystals rising from 2-phonon scattering processes is calculated. It is hown that the contribution to the scattering from the potential U_2, uadratic in the atomic displacement, is partially compensated by contribution from scattering from the potential U_1, linear in the isplacement. The relative correction to the mobility contains a erm λ_e/l, where λ_e is the electron wavelength and l is the electron mean free path, and a term of the form $A\tilde{u}^2/a^2$, where $\tilde{u}^2$ is the mean square atomic displacement, a is the lattice constant and A is temperature independent. The second term includes a correction to the effective mass, and to the deformation potential constant. [English translation in: Soviet Physics—Solid State (USA)].
K.G.Major

19710 CLOSED-SHELL ION—ION INTERACTIONS IN CALCIUM FLUORIDE.

J.R.Reitz, R.N.Seitz and R.W.Genberg.
J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 73-8 (April, 1961).

The short range ion—ion interactions in calcium fluoride are assumed to have the form $\phi_{ij} = A_{ij}\exp(-r/\rho)$. By calculating the electrostatic contribution to the elastic constants of calcium fluoride and comparing the results with the experimentally observed constants, it is determined that $\rho = 0{\cdot}28 \times 10^{-8}$ cm, A_{+-} for $Ca^{2+}—F^-$ is $3{\cdot}09 \times 10^{-9}$ ergs, and A_{--} for $F^-—F^-$ is $1{\cdot}04 \times 10^{-9}$ ergs. These results indicate that the $Ca^{2+}—F^-$ interaction is about ten times larger than the $F^-—F^-$ interaction in this crystal. The deviation from the Cauchy relation is investigated by means of a model which allows relative motion between the sublattices making up the crystal; the model proves inadequate, however, and it is concluded that the failure of the Cauchy relation is due to a many-electron interaction between ions which cannot be approximated by a central interaction.

THEORY OF INELASTIC SCATTERING OF NEUTRONS BY IMPERFECT CRYSTALS. See Abstr. 20501

Thermal Properties

19711 THE USE OF PHASE DIAGRAMS FOR INFORMATION ON THERMODYNAMIC INTERACTIONS.

E.Bonnier and P.Desré.
C.R. Acad. Sci. (France), Vol. 253, No. 5, 867-9 (July 31, 1961).
In French.

Thermodynamic relations are used to determine the partial heat of one of the components of a binary metallic system possessing a monotectic and a compound of fixed composition. Its application to 22 alloy systems is briefly discussed.
A.E.Kay

THERMAL PROPERTIES OF NaCl-TYPE CRYSTALS. See Abstr. 19690

19712 THE SPECIFIC HEAT OF DYSPROSIUM BETWEEN 0.5° AND 4°K.

B.Dreyfus, B.B.Goodman, G.Trolliet and L.Weil.
C. R. Acad. Sci. (France), Vol. 253, No. 9, 1085-7 (Aug. 28, 1961).
In French.

Three specimens of dysprosium from different sources were used for the determination of the specific heat below 4°K. For two of these it would appear that the specific heat values are strongly influenced by impurities but for one specimen the results are represented by $C = AT^{-2} + \gamma T + \beta T^3$, with $A = 30 \pm 2$ mJ mole^{-1} deg, $\gamma = 9.0 \pm 0.3$ mJ mole^{-1} deg^{-2} and $\beta = 0.22 \pm 0.02$ mJ mole^{-1} deg^{-4}. The γ value is in good agreement with those for metals with similar structures. The value of β leads to $\theta_D = 207^\circ \pm 7^\circ$K.
F.E.Hoare

19713 SPECIFIC HEAT ANOMALIES ASSOCIATED WITH THE RESISTANCE-MINIMUM PHENOMENA IN MAGNESIUM—MANGANESE ALLOYS. D.L.Martin.

Canad. J. Phys., Vol. 39, No. 9, 1385-7 (Sept., 1961).

Measurements in the 0.4 to 1.5°K range confirm the existence of anomalies. For the concentrated alloy used, the maximum of the specific heat anomaly is probably at the same temperature as the minimum in electrical resistance.
C.A.Hogarth

19714 THE DETERMINATION OF THE CONFIGURATIONAL SPECIFIC HEAT OF MANY-COMPONENT SPINELS.

A.N.Men'.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2466-9 (Aug., 1961).
In Russian.

The investigation of the concentration and temperature dependence of the configurational specific heat at high temperatures, and of the significance of the temperature T_0, at which the specific heat of spinels of the form $(A_{1-\lambda}B_{\lambda})_T(A_{1+\lambda}B_{1-\lambda})O_4$ has a maximum. [English translation in: Soviet Physics—Solid State (USA)].

G.E.Murphy

19715 LOW TEMPERATURE SPECIFIC HEAT OF MOLYBDENUM. C.A.Bryant and P.H.Keesom

J. chem. Phys. (USA), Vol. 35, No. 3, 1149-50 (Sept., 1961).

Two specimens were measured between 1 and 4.5°K. For the purer (99.99%) and denser specimen (within 1.5% of the perfect crystal value) the specific heat fits the Debye T^3 law with an electronic term where Θ = 458 ± 15°K and γ = 1.91 ± 0.02 mJ mole^{-1} deg^{-2}. Comparison with other work is shown in a table.

R.Berman

19716 HEAT CAPACITY OF $LiCuCl_3.2H_2O$.

H.Forstat and D.R.McNeely.

J. chem. Phys. (USA), Vol. 35, No. 5, 1594-6 (Nov., 1961).

The heat capacity was measured in the temperature range 2°-9°K. A λ-type anomaly in the heat capacity curve was observed at 4.40 ± 0.02°K. This is identified as the Néel temperature for a paramagnetic—antiferromagnetic transition. The magnetic entropy associated with this transition is 1.35 cal/mole deg which agrees with the theoretical value to within 2% if the spin of the magnetic ion is taken as $\frac{1}{2}$ in R log(2S + 1). The fraction of the magnetic entropy above the Néel temperature is 0.48 which indicates a considerable amount of short-range ordering of the spins of the magnetic ions.

19717 LOW-TEMPERATURE HEAT CAPACITIES AND THERMODYNAMIC FUNCTIONS OF SOME PLATINUM AND PALLADIUM GROUP CHALCOGENIDES. I. MONOCHALCOGENIDES; PtS, PtTe, AND PdTe.

F.Grønvold, T.Thurmann-Moe, E.F.Westrum, Jr and E.Chang.

J. chem. Phys. (USA), Vol. 35, No. 5, 1665-9 (Nov., 1961).

Heat capacities of platinum monosulphide, platinum monotelluride, and palladium monotelluride were measured in the range 5-350°K. They show the normal sigmoidal temperature dependence with no evidence of transitions or other anomalies. The derived heat-capacity equations were integrated. Values of heat capacities, entropy and enthalpy increments, and of the free-energy function are tabulated for selected temperatures. At 298.15°K, the third-law entropies are 13.16 cal gfw^{-1} °K^{-1} for PtS, 19.41 cal gfw^{-1} °K^{-1} for PtTe, and 21.42 cal gfw^{-1} °K^{-1} for PdTe. The new data on PtS have been correlated with existing decomposition-pressure data to evaluate ΔHf, ΔFf, and ΔSf 298.15°K. Entropies for other platinum-metal monochalcogenides were estimated.

19718 LOW-TEMPERATURE HEAT CAPACITIES AND THERMODYNAMIC FUNCTIONS OF SOME PALLADIUM AND PLATINUM GROUP CHALCOGENIDES. II. DICHALCOGENIDES; PtS_2, $PtTe_2$, AND $PdTe_2$.

E.F.Westrum, Jr, H.G.Carlson, F.Grønvold and A.Kjekshus.

J. chem. Phys. (USA), Vol. 35, No. 5, 1670-6 (Nov., 1961).

Heat capacities of platinum disulphide, ditelluride, and palladium ditelluride were measured in the range 5° to 350°K. They show the normal sigmoidal temperature dependence with no evidence of transitions or other anomalies. The derived heat capacity equations were integrated. Values of C_p, $S^0 - S_0^0$, $H^0 - H_0^0$, and $-(F^0 - H_0^0)/T$ are tabulated for selected temperatures. At 298.15°K the entropies are 17.85 cal gfw^{-1} °K^{-1} for PtS_2, 28.92 cal gfw^{-1} °K^{-1} for $PtTe_2$ and 30.25 cal gfw^{-1} °K^{-1} for $PdTe_2$. Thermodynamic values have been estimated for other dichalcogenides and related chalcogenides of the platinum group metals.

19719 SPECIFIC HEAT OF $Cu(NH_3)_4SO_4.H_2O$ BELOW 1°K.

T.Haseda and A.R.Miedema.

Physica (Netherlands), Vol. 27, No. 12, 1102-12 (Dec., 1961).

The specific heat was measured down to 0.03°K, by studying the rate of change of the temperature when a single crystal of the salt was cooled through a known thermal resistance. Susceptibility measurements in the directions of the three crystalline axes were made. The results are in agreement with the idea that, as far as the magnetic interactions are concerned, the copper ions are arranged in linear chains. The specific heat shows a broad Schottky type maximum near 3°K and a small sharp maximum at 0.37°K which may correspond to the appearance of long range magnetic order. The susceptibility measurements are in general agreement with this picture. A value of J/k = −7°K is derived for the exchange constant in a chain, from the susceptibility as well from as the specific heat data.

19720 THE LOW TEMPERATURE SPECIFIC HEAT OF SCANDIUM AND YTTRIUM.

H.Montgomery and G.P.Pells.

Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 622-5 (Oct., 1961).

Specific heat measurements between 1.7° and 4.2°K are reported. Graphs of specific heat per deg K against (temperature are straight lines; the values of γ are 11.3 ± 0.1 mJ mole^{-1} deg K for Sc and 10.2 ± 0.1 for Y. Debye temperatures are 470° ± 80° K and 300° ± 10°K respectively. The electron band structures of the transition metals is discussed in the context of these results and the magnetic properties.

H.Myku

19721 THE ELECTRONIC SPECIFIC HEAT OF LITHIUM—MAGNESIUM ALLOYS. D.L.Martin.

Canad. J. Phys., Vol. 39, No. 9, 1388-90 (Sept., 1961).

Measurements in the range 0.2 to 2.5°K are reported for alloy containing 1 and 10 at.% Mg. The observed electronic specific hea decreases with increase of electron density whereas the Sommerfe free-electron value increases.

C.A.Hogar

19722 THE TEMPERATURE DEPENDENCE OF THE DEBYE TEMPERATURE Θ OF SILVER BY X-RAY DIFFRACTION MEASUREMENTS. M.Simerská.

Acta cryst. (Internat.), Vol. 14, Pt 12, 1259-70 (Dec. 10, 1961).

The study of the temperature dependence of the characteristic temperature Θ for silver in the temperature range from 18 to 760° is presented. The determination of Θ values from measured X-ra data was carried out by three procedures. Comparison with previ measurements is given.

19723 THERMAL EXPANSION OF TETRAGONAL TIN.

V.T.Deshpande and D.B.Sirdechmukh.

Acta cryst. (Internat.), Vol. 14, Pt 4, 35[illegible]-6 (April, 1961).

Accurate values of the lattice parameters of tetragonal tin were determined at various temperatures up to 151°C, using a back-reflection camera and Cohen's analytical procedure. These data were used to evaluate the two principal coefficients of thermal expansion and their variation with temperature. The room-temper ture results agree with those reported in the literature but the rate of increase of the coefficients with temperature are found to be higher. Values of the mean Grüneisen's constant are found to increase with temperature.

19724 THERMAL EXPANSION OF AMMONIUM BROMIDE, RUBIDIUM BROMIDE AND RUBIDIUM CHLORIDE.

V.T.Deshpande and D.B.Sirdeshmukh.

Acta cryst. (Internat.), Vol. 14, Pt 4, 353-5 (April, 1961).

The lattice constants of ammonium bromide, rubidium bromide and rubidium chloride were determined accurately at different temperatures, using a back-reflection camera, and the coefficients of thermal expansion were evaluated. The lattice constants of the three compounds at 20°C are 4.0587, 6.8908 and 6.5898 A respectively. The coefficients of expansion of ammonium bromide and rubidium bromide vary parabolically with temperature according to the equations,

$$\alpha = 58.96 \times 10^{-6} - 11.98 \times 10^{-8}T + 35.00 \times 10^{-10}T^2$$

and

$$\alpha = 38.00 \times 10^{-6} - 1.54 \times 10^{-8}T + 4.13 \times 10^{-10}T^2,$$

respectively. The lattice constant of rubidium chloride increases linearly with temperature and the mean coefficient of expansion fo the range of temperature 20-190°C is 38.13×10^{-6} (deg C)$^{-1}$.

19725 THE ANOMALOUS THERMAL EXPANSION OF CHROMIUM. G.K.White.

Austral. J. Phys., Vol. 14, No. 3, 359-67 (Sept., 1961).

Experimental data on the linear thermal expansion between 20 and 50°C of specimens of high-purity Cr confirm the existence of a anomaly centred at 38°C. The exact shape of this expansion anomaly between about 37° and 39°C varies markedly from sample to sample, but outside this narrow temperature interval the behaviour is more regular and seemingly related to antiferromagne ordering. Data on expansion are compared with other recent observations on heat capacity, magnetic susceptibility, and electric resistivity of high-purity chromium. It is suggested that an electronic term in the expansion coefficient, observed below 20°K be negative, is sensitive to band structure and may be partly responsible for the change in the expansion coefficient.

19726 THERMAL EXPANSION OF α-PLUTONIUM. N.T.Chebotarev and A.V.Beznosikova.
mnaya Energiya (USSR), Vol. 7, 68 (1959). In Russian.
glish translation in: Reactor Sci. (GB), Vol. 12, No. 3, 127-8
ne, 1960).

The lattice parameters of α-plutonium were determined by an ray method over the temperature range -196° to $+100^\circ$C. The rmal expansion coefficients in the three principal directions are rived and show satisfactory agreement with previous determina-ns. R.F.S.Hearmon

THERMAL EXPANSION OF BINARY NICKEL ALLOYS.
e Abstr. 20305

19727 EHRENFEST RELATIONS IN CRYSTALLINE MEDIA. R.Viswanathan and E.S.Rajagopal.
ysica (Netherlands), Vol. 27, No. 8, 765-7 (Aug., 1961).

Starting from the thermodynamic potential expressed as a ction of temperature and the six stress components, the authors rive an Ehrenfest relation which reduces to the usual one for a bic crystal in air. They further note a new relation involving ear coefficients of expansion and compressibility for this case. B.V.Thompson

19728 AN EXPERIMENTAL EQUATION OF STATE FOR SODIUM. R.I.Beecroft and C.A.Swenson.
Phys. Chem. Solids (GB), Vol. 18, No. 4, 329-44 (March, 1961).

An experimental equation of state for sodium was obtained for essures to 20 000 atm and for temperatures from 20°K to the elting point. Various experimental details are given of an paratus with which it is possible to obtain pressure–volume data hich are reliable to $\pm 0{\cdot}002$ in $\Delta V/V_0$ over this range of temper-ure and pressure. The equation of state can be represented to ithin the above accuracy by an expression which is derived from e assumption that the isothermal compressibility is linear with lume and has no explicit temperature dependence. A discussion given of the effect of these assumptions on the validity of calcu-tions of the variation with volume of the temperature dependent ntribution to the thermodynamic functions. Grueneisen constants s obtained from various definitions are calculated as functions of mperature and volume, and the validity of the Mie–Grueneisen uation of state as it applies to sodium appears open to question low room temperature. Recent high pressure ultrasonic experi-ents on sodium are interpreted as being in agreement with this nclusion.

19729 INFLUENCE OF HALOGEN IMPURITIES ON THE THERMAL CONDUCTIVITY OF LEAD TELLURIDE.
D.Devyatkova and I.A.Smirnov.
iz. tverdogo Tela (USSR), Vol. 3, No. 8, 2298-2309 (Aug., 1961).
Russian.

Measurements are reported over the temperature range 0°-460°K of the thermal conductivity, electrical conductivity, Hall oefficient, and thermoelectric e.m.f. of PbTe containing Cl, Be, I, e and Sn as impurities. The halogens lower the lattice thermal onductivity appreciably, whereas Se and Sn have little ffect. The electrical conductivity, thermoelectric e.m.f. and hermal conductivity do not depend on the particular halogen resent as impurity. The results are discussed in relation to honon scattering in the material. [English translation in: oviet Physics—Solid State (USA)]. R.F.S.Hearmon

19730 CHANGE OF THERMAL CONDUCTIVITY OF SOME Cd–Sn AND Bi–Sn ALLOYS ON MELTING.
.P.Pashaev.
iz. tverdogo Tela (USSR), Vol. 3, No. 8, 2442-4 (Aug., 1961).
n Russian.

The thermal conductivity (κ) of tin alloys containing 5, 50, and 0% Sn and 50% Bi was measured between about 50 and 350°C. The hange in conductivity at the melting point is interpreted in terms of short-range order structure. The measured value of the ratio κ_s/κ_l ("s" and "l" denote solid and liquid phases, respectively) gives satisfactory agreement with theory for Cd–Sn alloys. English translation in: Soviet Physics—Solid State (USA)]. R.F.S.Hearmon

19731 THERMAL CONDUCTIVITY MEASUREMENTS OF SILICON FROM 30° TO 425°C.
R.G.Morris and J.G.Hust.
Phys. Rev. (USA), Vol. 124, No. 5, 1426-30 (Dec. 1, 1961).

Measurements on single-crystal silicon show that the thermal conductivity varies nearly as T^{-1}, from 1.26 ± 0.19 W cm^{-1} (deg C)$^{-1}$ at 30°C, to 0.46 ± 0.07 W cm^{-1} (deg C)$^{-1}$ at 425°C. The series comparative method employed reduces errors due to radiation, thermocouple calibration, and contacts. The charged-carrier contribution to the conductivity is less than 1% at 425°C. The lattice conductivity is discussed in terms of phonon–phonon scattering at 425°C and in terms of isotope and phonon–phonon scattering at 30°C.

ON THE DISTRIBUTION OF TEMPERATURES IN SOLIDS UNDER A FLUX OF HEAT. See Abstr. 18656

ANOMALY IN THE DISTRIBUTION OF TEMPERATURE IN THE SURFACE LAYERS OF A SOLID. See Abstr. 18654

THE CONVECTIVE MECHANISM OF THERMAL CONDUCTIVITY IN SUPERCONDUCTORS. See Abstr. 18709

MEASUREMENT OF THE ANSIOTROPY OF THERMAL CONDUCTIVITY OF ZINC AND CADMIUM IN THE SUPER-CONDUCTING STATE. See Abstr. 18724

ELECTRON STATES

19732 EXAMPLES OF APPLICATION OF THE PREMISSION METHOD TO REACTION-KINETIC PROBLEMS IN SOLID-STATE PHYSICS. S.Oberländer.
Phys. Status solidi (Germany), Vol. 1, No. 1, 81-9 (1961). In German.

The premission method for the qualitative discussion of solution functions of systems of common differential equations, as developed by the author (Abstr. 6082 of 1961), is briefly formulated, and applied to various reaction-kinetic models in solid-state physics. The versatility of the method is demonstrated by verifying the definiteness, boundedness and monotony of the solution curves of systems of nonlinear differential equations for reaction kinetics. The sign of the deviation of an approximate solution from the exact solution can be determined. This is demonstrated for the case of the quasi-stationary approximation.

COLLECTIVE BEHAVIOUR IN SOLID-STATE PLASMAS.
See Abstr. 19847

19733 DIRECT OBSERVATION OF OPEN MAGNETIC ORBITS. J.C.Phillips.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 162-3 (Dec., 1960).

If the Fermi surface of a metal is multiply connected, application of a magnetic field may cause the electron to move across the Fermi surface on an open orbit, which extends indefinitely through momentum space, and the real-space motion will also be unbounded. It is pointed out that these open orbits may be periodic, in which case they can be observed in cyclotron resonance experiments, though it may be necessary to tilt the magnetic field out of the specimen surface (Abstr. 6259 of 1960). The orbits will not be quantized in energy, and so will not contribute to the de Haas–van Alphen effect. R.G.Chambers

19734 ENERGY GAPS IN BISMUTH TRIOXIDE. D.M.Mattox and L.Gildart.
J. Phys. Chem. Solids (GB), Vol. 18, 215-17 (Feb., 1961).

A method of preparing polycrystalline films of Bi_2O_3 having thicknesses in the range 10 to 100 μ is presented. Temperatures versus resistance measurements give a thermal energy gap of 2.07 ± 0.07 eV in the temperature range 400°-550°K. Optical transmission studies at room temperature and liquid nitrogen temperature give optical energy gaps of 3.1 eV at 77°K and 2.85 eV at 300°K. Thus there is an apparent temperature dependence of -1.1×10^{-3} eV/$^\circ$K in this temperature range assuming a linear variation.

19735 ENERGY-BAND STRUCTURE OF SOLIDS FROM A PERTURBATION ON THE "EMPTY LATTICE".
F.Bassani and V.Celli.
J. Phys. Chem. Solids (GB), Vol. 20, No. 1-2, 64-75 (June, 1961).

The unperturbed Hamiltonian consists of the kinetic part and of a uniform potential; the perturbing operator is the crystal potential plus a term which originates from the requirement that valence and conduction states be orthogonal to the inner states. This amounts to an approximation to the OPW method. Reasons are given for the validity of such a simple scheme and applications are made to the case of the diamond lattice and of the zincblende lattice. It is shown how features of the energy-band structure depend on the symmetry of the lattice, on the lattice parameter and on the "core states" of the atomic components. Numerical results obtained for diamond, silicon and BN are in fair agreement with recent calculations. An energy-band structure consistent with experiment is obtained for Ge and GaAs by fixing the values of a few parameters.

19736

INVERTED NATURE AND SIGNIFICANCE OF NEGATIVE-MASS LANDAU LEVELS. G.C.Dousmanis.

Phys. Rev. (USA), Vol. 124, No. 5, 1417-22 (Dec. 1, 1961).

Quantum-mechanical considerations on negative-effective-mass carriers in crystals show the following: the energy-level structure of particles with negative effective mass, in the presence of a magnetic field, consists of a system of inverted Landau levels. A simple derivation of the level inversion is given. Sharp contradistinctions are found on the behaviour of the levels by comparsion to that of positive-mass regions of momentum space. The significance of this type of level structure for cyclotron resonance transitions, in particular in the case of the observed small negative-mass branch of heavy holes in Ge, is discussed.

19737

EVIDENCE FOR SPIN—ORBIT SPLITTING IN THE BAND STRUCTURE OF ZINC AND CADMIUM.

A.S.Joseph, W.L.Gordon, J.R.Reitz and T.G.Eck.

Phys. Rev. Letters (USA), Vol. 7, No. 9, 334-6 (Nov. 1, 1961).

Detailed de Haas—van Alphen effect measurements on zinc and cadmium were made which cannot be accounted for with any Fermi surface model in which spin—orbit coupling is neglected. The "magnetic breakdown" of the spin—orbit energy gap is also discussed.

J.F.Cornwell

QUASICLASSICAL QUANTIZATION IN THE NEIGHBOURHOOD OF SINGULAR CLASSICAL TRAJECTORIES: APPLICATION TO A METAL IN A MAGNETIC FIELD. See Abstr. 18280

BAND STRUCTURE OF ANTIMONY. See Abstr. 19833

BAND STRUCTURE OF IRON, COBALT AND NICKEL. See Abstr. 19914

ENERGY BAND STRUCTURE AND OPTICAL PROPERTIES OF METALS AND ALLOYS. See Abstr. 19938

ENERGY LEVEL STRUCTURE OF CUPROUS OXIDE. See Abstr. 19986

ELECTRON ENERGY STRUCTURE OF Mg ALLOYS. See Abstr. 20296

ELECTRONIC STRUCTURE OF ζ-PHASES BASED ON SILVER. See Abstr. 20571

19738

THE FERMI SURFACE.

W.A.Harrison.

Science (USA), Vol. 134, 915-20 (Sept. 29, 1961).

A general review including diagrams for particular metals and a short account of experimental techniques.

19739

THE FERMI SURFACES OF THE NOBLE METALS BY ULTRASONICS. R.W.Morse.

Fermi Surface Conference Paper,Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 214-23; Disc., 258-63.

The shapes of the Fermi surfaces of copper, gold, and silver as revealed by ultrasonic attenuation measurements are reviewed. The experimental method employed is an oscillatory variation of attenuation with magnetic field. A variety of orbit types are found to contribute oscillatory components from which many of the characteristic dimensions of the Fermi surfaces can be calculated. It is found that all three noble metals make significant zone boundary contact in the [111] directions. For copper and gold the data give a direct measurement of the radius of the touching area, an estimate of the shape of the neck joining the zone boundary, as well as radii of the main body of the surface in several directions.

19740

THE FERMI SURFACE IN TIN FROM ULTRASONIC ATTENUATION. T.Olsen.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961), p. 237-44 ; Disc., 258-63.

The magnetic-field dependence of the ultrasonic attenuation was measured in very pure tin single crystals at low temperature where the electron mean free path is comparable to the acoustical wavelength. The oscillatory variation of the attenuation when the field is perpendicular to the direction of sound propagation yields, in a very direct way, information about the Fermi surface. Some preliminary studies of these measurements have been presented earlier by Olsen (Abstr. 9847 of 1960) and by Olsen and Morse [Bull. Amer. Phys. Soc., Vol. 4, 167 (1959)]. Here the measurements are treated in greater detail and re-examined in the light of the very successful "nearly-free-electron" approximation used by Gold (1958) on lead and Harrison (1959) on aluminium both to study de Haas—van Alphen data. Both compressional waves and shear waves were propagated along four different directions in the crysta The magnetic dependence of the attenuation and hence the Fermi momenta were found to be very anisotropic, but in general agreement with the Fermi surface suggested from the "nearly-free-electron" approximation.

19741

SOME FERMI SURFACE MEASUREMENTS IN SILVER

H.V.Bohm.

Fermi Surface Conference Paper Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961), p. 245-50; Disc., 258-63.

Measurements at liquid-helium temperatures using ultrasonic pulses of frequencies above 100 Mc/s were made in a single cryst silver sample. The attenuation was examined as a function of magnet field strength and direction. Results are compared with those of Morse et al. (1958, 1960), and Mielczarek et al. (1960). Some previously unreported Fermi momenta are given. Some shear wav data, the interpretation of which is not clear, is also presented.

19742

THE POSSIBLE RELATION BETWEEN THE SHAPE O THE FERMI SURFACE AND THE MAGNETIC-FIELD ROTATION DIAGRAMS OF ULTRASONIC ATTENUATION.

L.Mackinnon and M.T.Taylor.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 251-7; Disc., 258-63.

Experiment has shown that the value of the electronic component of megacycle ultrasonic attenuation in pure metals can depend markedly both on the magnitude and on the direction of an applied magnetic field. If the magnitude of the field is kept constant and if the field is rotated in a plane perpendicular to the propagation direction of the sound, then marked anisotropy may be seen in the absorption-field direction plot for both longitudinal and shear wave On the free-electron model, this anisotropy would not be expected to occur for longitudinal waves and is usually not of the form that can be predicted for shear waves. Among the theoretical treatments of the absorption problem on the free-electron model (spherical Fermi surface) is that of Cohen, Harrison and Harrison (Abstr. 6011 of 1960). One of the authors has extended this treatment first to an ellipsoidal Fermi surface and secondly to a Fermi surface consisting of a number of ellipsoids arranged with cubic symmetry. Preliminary calculations from this theory provide a qualitative picture of the anisotropy in the rotation diagrams. Whe however the field is rotated in the plane containing the propagation direction, experimental results on a lead specimen are obtained which in certain ways do not seem to correspond with any present theory, although they are probably related in some similar way to the shape of the Fermi surface.

19743

THE MANY-BODY THEORY OF ELECTRONS IN MET OR HAS A METAL REALLY GOT A FERMI SURFACE

L.M.Falicov and V.Heine.

Advances in Phys. (GB), Vol. 10, 57-105 (Jan., 1961).

19744

BISMUTH FERMI SURFACE.

W.A.Harrison.

J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 171-3 (Dec., 1960).

The Fermi surface of bismuth in the single-OPW approximati

e. the free electron approximation) is obtained, and the modifications produced by the introduction of a potential and of spin—orbit upling are discussed. J.F.Cornwell

19745 THE FERMI SURFACE AREAS OF MAGNESIUM, ZINC AND CADMIUM. E.Fawcett.

Phys. Chem. Solids (GB), Vol. 18, No. 4, 320-8 (March, 1961).

The surface conductance under anomalous skin effect conditions polycrystalline samples of the hexagonal divalent metals magnesm, zinc and cadmium is measured and used to determine their ermi surface areas. The results for zinc and cadmium are in od agreement with the theoretical values, which are estimated in e nearly-free electron approximation for recently proposed odels of their Fermi surfaces. For magnesium the Fermi energy regarded as a variable parameter, and the experimental value r the area provides a sensitive measure of its position relative the calculated energy levels at points of high symmetry in the rillouin zone. The area for each metal when combined with the c. conductivity and the electronic specific heat also yields verage values of the mean free path and Fermi velocity.

19746 FERMI SURFACE TOPOLOGY OF EVEN-VALENT METALS FROM THEIR MAGNETORESISTANCE NISOTROPY. E.Fawcett.

hys. Rev. Letters (USA), Vol. 6, No. 10, 534-7 (May 15, 1961).

FERMI SURFACE OF COPPER FROM MAGNETORESISTANCE ND HALL EFFECT. See Abstr. 19834

19747 IMPURITY STATES IN SOLID NEON. A.Gold.

. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 218-37 (Feb., 1961).

A treatment of optical absorption by an isolated substitutional mpurity centre is given. The tight-binding approximation is used nd the method of constructing one-electron trial functions for the ystem is outlined. The first-order absorption energies, oscillator trengths and integrated absorption coefficients are computed in an pproximation which includes spin—orbit interaction and the overapping of heterocentric atomic wave-functions through terms of rder S^2. The first-order energies are corrected for van der Waals nteractions using a variational formalism. A phenomenological method for computing the emission energies of the system is given. The specific example of an argon impurity atom in solid neon is reated numerically. The computation predicts absorption lines at 1.7 and 11.6 eV due, respectively to the $^1P_1$ and $^3P_1$ states of the rgon impurity, with an uncertainty of 1.3 eV. The oscillator trengths for these transitions are calculated to be 0.164 and 0.017 espectively, giving rise to integrated absorption coefficients of .84 × 10^6 N_0 and 0.09 × 10^6 N_0 eV cm^{-1} for the two states, where N_0 s the (small) fractional concentration of impurities in the host attice.

19748 CALCULATION OF ENERGIES OF 2-p EXCITED EXCITON STATES WITH INTERMEDIATE COUPLING.

G.Zaslavskaya.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2240-4 (Aug., 1961). In Russian.

The calculation of energies of 2p exciton states, assuming the variable parts of the displacements of the normal coordinates of the crystal lattice vibrations from equilibrium, $q_{\chi m}$, are identical for all excited states, and equal to $q_{\chi 1s}$ for the ground state. The results are compared with those obtained for weak coupling. [English translation in: Soviet Physics—Solid State (USA)]. G.E.Murphy

EXCITON EXCITATIONS IN SUPERCONDUCTORS. See Abstr. 18709

THE EFFECT OF THE MAGNETIC FIELD INVERSION ON THE EXCITON ABSORPTION SPECTRUM OF A CdS CRYSTAL. See Abstr. 19971

THE EXCITON SPECTRUM OF ZINC OXIDE. See Abstr. 19982

PARAMAGNETIC EXCITONS IN MOLECULAR CRYSTALS. See Abstr. 20194

19749 BIPOLARON STATES OF CHARGE CARRIERS IN IONIC CRYSTALS. V.L.Vinetskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1459-68 (May, 1961). In Russian.

Considers a system consisting of two conduction electrons in an ionic crystal which interact with the polarization and elastic deformations of the crystal. It is shown that the previous conclusion (Abstr. 2032 of 1958) regarding the possibility of bipolaron formation does not essentially depend on the approximation used (variational method, classical treatment of ion motion) and can be obtained by using more vigorous methods. The elastic deformation, which was not taken into account in earlier work, leads to an improvement of the existence criterion and to an increase of the bipolaron energy. The motion of bipolarons is analysed and the ground-state energy, effective mass and moment of inertia are calculated. It is concluded that at sufficiently low temperatures, bipolaron states of charge carriers may exist in ionic crystals. [English translation in: Soviet Physics—JETP (USA)].

19750 ABSORPTION OF ELECTROMAGNETIC RADIATION BY AN ELECTRON GAS. N.Tzoar and A.Klein.

Phys. Rev. (USA), Vol. 124, No. 5, 1297-1306 (Dec. 1, 1961).

The total absorption cross-section for a photon by an electron gas is calculated in the high-density limit. The calculation makes use of the Green's function formulation of the many-body problem. Only the simplest final states leading to a nonvanishing cross-section, consisting of an electron—hole pair and a plasmon, are taken into account. This contribution has a threshold near the plasmon energy and is peaked owing to the initially rapid rise of the available phase space, with a total cross-section for real metals of 10^{-17}-10^{-19} cm^2 per electron. This compares favourably with other absorption mechanisms.

19751 ALFVÉN WAVES IN SOLID-STATE PLASMAS. S.J.Buchsbaum and J.K.Galt.

Phys. of Fluids (USA), Vol. 4, No. 12, 1514-16 (Dec., 1961).

Alfvén waves can be studied experimentally in certain solid-state plasmas with greater facility than in gaseous plasmas. This results from the fact that in these solid-state plasmas all the charge carriers have masses equal to or less than the free electron mass. Alfvén waves can thus be studied at microwave frequencies. Previously published experimental results on microwave absorption in bismuth are reinterpreted in terms of the properties of Alfvén waves.

19752 ON THE POSSIBILITY OF DETERMINING THE CORRELATION FUNCTION FOR A FERMI LIQUID IN METALS. M.Ya.Azbel'.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1138-47 (Oct., 1960). In Russian.

A set of equations for the general case of the electron Fermi liquid in an electromagnetic field is given in a form which is more convenient than the one normally used. The simplicity of the proposed form is conserved also for an electron gas. It is shown that the liquid properties at high frequencies manifest themselves always in the same way as the presence of an electrical field normal to the metal surface. The only case in which the Fermi liquid effects turn out to be important is that of cyclotron resonance at very high frequencies — appreciably higher than those considered before. The Fermi liquid then leads in particular to an additional broadening of the resonance curve. The possibility of determining the correlation function in metals in this case is discussed. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 793-8 (April, 1961)].

QUANTUM THEORY OF THE SPECTRUM OF EXCITATIONS OF AN ELECTRON GAS IN A MAGNETIC FIELD. See Abstr. 18903

19753 ANNIHILATION OF POLARIZED POSITRONS IN MAGNETIZED IRON. W.D.McGlinn.

Nuovo Cimento (Italy), Vol. 22, No. 2, 225-34 (Oct. 16, 1961).

An attempt is made to describe the integral, angular correlations for annihilation of polarized positrons in iron for a saturating magnetic field. A comparison with experiment is made. The positron wave-function used to calculate the angular correlation for annihilation of the 3s, 3p, and 3d electrons of iron was that obtained by a Wigner—Seitz calculation for zero crystal momentum, the potential in the Schrödinger equation being taken as the ion core potential. The inner electron wave-functions were assumed to be those of free atomic iron. The angular correlation for the conduction electron annihilation was calculated assuming a degenerate Fermi gas for the electrons and a zero-momentum wave-function for the positron.

19754 ENHANCEMENT OF THE LONG-LIVED POSITRONIUM ANNIHILATION RATE BY A STATIC ELECTRIC FIELD.

A.Bisi, A.Fasana and L.Zappa.
Phys. Rev. (USA), Vol. 124, No. 5, 1487-8 (Dec. 1, 1961).

For previous work, see Abstr. 8901 of 1961. The annihilation rate of the long-lived component of positronium in solid dielectrics was investigated as a function of an applied static electric field. It was found that in some materials like paraffin, polyethylene, and Teflon the triplet positronium decays, in the presence of the field, at a rate greater than the usual "pick-off" annihilation rate. Within the experimental accuracy the lifetimes τ in the three materials display the same trend with the field, which is expressed by the equation $\tau_E = \tau_0(1 - \alpha E)$, where $\alpha = (9.3 \pm 1.3) \times 10^{-4}$ cm/kV. No effect was found in some typical polar polymers, for instance, Lucite, Nylon, and polyvinyl chloride.

19755 POSITRON ANNIHILATION IN SULPHUR, SELENIUM AND SILICON.

K.A.Baskova, B.S.Dzhelepov and Z.A.Komissarova.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1001-3 (April, 1961).
In Russian.

The angular distribution of annihilation γ-rays is measured for crystalline and amorphous S, Se and Si. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 703-4 (Oct., 1961)].

19756 CROSS MODULATION LINE PROFILES IN CYCLOTRON RESONANCE EXPERIMENTS. L.Gold.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1643 (Aug., 1961).

Describes preliminary work which takes into account the dispersive effect of free cariers. The investigation of scattering processes by cross modulation techniques is proposed.

G.C.Williams

19757 LINEWIDTH OF CYCLOTRON RESONANCE OF PURE GERMANIUM.

H.Kawamura, M.Fukai, Y.Hayashi and T.Hashimura.
J. Phys. Soc. Japan, Vol. 16, No. 8, 1646 (Aug., 1961).

Results obtained are not in agreement with those of Michel and Rosenblum [Bull Amer. Phys. Soc., Ser. II. 6, 115 (1961)] but the reason for the discrepancy is not understood. G.C.Williams

19758 THEORY OF CYCLOTRON RESONANCE IN ANISOTROPIC METALS.

H.Suzuki, M.Hattori and K.Ariyama.
J. Phys. Soc. Japan, Vol. 16, No. 10, 1947-62 (Oct., 1961).

The semi-classical Boltzmann theory of Rodriguez for an isotropic metal (Abstr. 4015 of 1959) is extended to the simplest model of a uniaxial anisotropic metal in which the surfaces of constant energy take the form of ellipsoids of revolution about the principal axis of the crystal. The surface impedance, in the extreme anomalous skin effect region and in the presence of a constant magnetic field parallel to the metal surface, is calculated assuming the specular reflection boundary condition and including the interaction between the individual circular motion of the conduction electrons and the electric field produced by polarization of the charge distribution in the metal. This model, although somewhat artificial, makes it possible to carry out the calculation exactly and the main features of the phenomenon of cyclotron resonance in anisotropic metals can be seen.

19759 MEASUREMENT OF HALF-WIDTH OF ENERGY LOSS LINE IN THE ENERGY LOSS SPECTRA OF 20 keV ELECTRONS PASSING THROUGH FOILS OF ALUMINIUM AND MAGNESIUM. S.Arai.

Sci. Rep. Tohoku Univ. First Ser.(Japan), Vol. 43, No. 3, 121-30 (Oct., 1959).

The half-widths of energy loss lines observed in the energy loss spectrum of 20 keV electrons passing through Al foil of thickness 500 A or Mg foil of thickness 600 A were carefully measured. The half-widths were measured by the use of a primary electron beam of half-width 0.18-0.20 eV keeping the total beam current at 1.5 μ To obtain such a fine beam, a special cathode was devised. The cathode was made by the use of BaO—SrO coated on an extremity of a Pt—Mg alloy wire of diameter 0.1 mm. As to the Al spectrur the half-widths of energy loss lines corresponding to energy losses 14.8 eV and 29.7 eV respectively were measured. The hal width of zero loss line was 0.34 eV for Kodak plates, spectrum analys No. 1. The half-width of the loss line 14.8 eV was 1.41 eV for Al Fuji plates and 1.43 eV for Kodak plates. The half-width of the line loss line was 1.60 eV for Fujii plates and 1.63 eV for Kod plates. The half-width of the 29.7 eV line was about 1.14 times as large as that of the 14.8 eV line. As to the Mg spectrum, the half-widths corresponding to energy losses 10.3 eV and 20.7 eV respec ely were measured. The half-width of the zero loss line were 0.37 eV for Kodak plates. The half-width of the 10.3 eV line was 1.41 eV for Fuji plates and 1.42 eV for Kodak plates. The half-width of the line 20.7 eV was 1.62 eV for Fuji plates and 1.63 eV Kodak plates. The half-width of the line 20.7 eV was about 1.14 times as large as that of the line 10.3 eV. The difference between the half-widths of the two lines mentioned above for Al is consider and it seems to be too small compared with the difference estimat from the multiple excitation in general, including plasma excitatio It holds also for the case of Mg. The measurements were also ma keeping the total beam current 8 μA, and the half-width of the primary beam was 0.34 eV for Kodak plates. Then the main resul mentioned above was almost unaltered.

SOME MEASUREMENTS ON ENERGY LOSS OF 2.8 MeV ELECTRONS IN LIGHT ELEMENTS AND CHEMICAL COMPOUND

See Abstr. 18935

19760 THE ANGLE OF DIVERGENCE OF PAIRS PRODUCED BY PHOTONS IN A CRYSTAL. A.Levi.

Nuovo Cimento (Italy), Vol. 22, No. 3, 471-86 (Nov. 1, 1961).

The distribution of the angle of divergence of pairs produced by high-energy photons in a crystal differs in many features from the usual one-atom distribution. This difference is calculated by taking into account the number of reciprocal points corresponding to the various angles. The result is, that, if the photon beam is incident on the crystal normally to a lattice plane, although the total cross-section is less than the one-atom cross-section, there are some angles where large constructive interferences occur. If on the other hand, the photon beam makes a small but finite angle with the normal to a lattice plane, the crystal distribution oscillat around the one-atom distribution. Numerical calculations were made with an IBM 650 computer.

DEFECT PROPERTIES

19761 ELECTRON THEORY OF INTERACTION BETWEEN POINT DEFECTS IN METALS.

G.K.Corless and N.H.March.
Phil. Mag. (GB), Vol. 6, 1285-96 (Oct., 1961).

By employing a simple model of point charges in a uniform electron gas, it is shown how interaction energies between imperfe tions (for example, impurity—vacancy or vacancy—vacancy interacti may be evaluated within the framework of low-order perturbation theo Close contact may be established throughout with the earlier investiga tion of Alfred and March (Abstr. 8428 of 1956; 8738 of 1957), in which, however, a restrictive assumption that the perturbing potential was slowly varying had to be made. The present work removes thi assumption completely and provides a firm basis for the so-called "electrostatic model" of the interaction between imperfections. In view of the long-range oscillations in the electrostatic potential around a defect, the interaction energy also has an oscillatory behaviour as a function of distance. The relevance of the present wo to the Lazarus theory (Abstr. 5019 of 1954) of impurity diffusion in metals is discussed. In this case, the numerical results are in fai agreement with those of the earlier treatment, and lend further sup port to the Lazarus theory. Also the investigation of Seeger and Bross (Abstr. 6402 of 1956) on the di-vacancy may be critically ex amined by comparison with the present findings. It then appears that the terms in the total interaction energy which these earlier workers have omitted may be large. Indeed, in the present calcula is they are sufficient to change the sign of the interaction. It is lly pointed out that the present theory may have relevance in the erpretation of the results of Biondi and Rayne (Abstr. 1542 of 0; 1156 of 1961) on optical absorption in Cu—Zn and Cu—Ge alloys.

FLUORESCENCE CENTRES IN ZnS AND LATTICE DEFECTS.
e Abstr. 20014

ELECTRON MICROSCOPE IMAGES OF CRYSTAL LATTICE FECTS. II. THE DEVELOPMENT OF A DYNAMICAL THEORY.
Abstr. 20710

19762 QUENCHED-IN VACANCY IN SOLID SOLUTION ALLOYS. Y.Hamaguchi.

Phys. Soc. Japan, Vol. 16, No. 9, 1692-7 (Sept., 1961).

The binding energy for a vacancy and a solute atom was deter-ned from the difference in the electrical resistivity change luced by quenching between pure Au and Au—Pd solid solutions. e rate of decrease with decreasing temperature of quenched-in ditional resistivity in the alloy was more rapid than in the pure etal, and the resistivity after quenching was smaller than that fore quenching in high concentration alloys below a certain enching temperature. It was concluded that the interaction of a atom with a vacancy in Au—Pd alloys was attractive which ntrasted with the expectation of Lazarus theory (1960), and an ditional resistivity by the solute atom was concealed partly by binding of the vacancy. In Ag—Pd alloys the same results would expected.

19763 GENERATION OF VACANCIES DURING PLASTIC DEFORMATION OF KCl CRYSTALS.

.Camagni, G.Chiarotti and A.Manara.
Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 165-8 (Dec., 1960).

Experiments are described on the effect of plastic strain on the nductivity of KCl crystals in the temperature range -170^0 to 0^0 C. Two distinct effects are observed: (1) there is a large dden increase of conductivity during the plastic strain; (2) at mperatures higher than -10^0 C there is an additional component, hich appears as a tail of the initial peak and decays in a time of e order of minutes. These observations enable the authors to stimate directly the value of the migration energy for a positive-n vacancy (0.45 eV). R.Bullough

19764 THEORETICAL CALCULATIONS OF THE ENTHALPIES AND ENTROPIES OF DIFFUSION AND VACANCY ORMATION IN SEMICONDUCTORS. R.A.Swalin.

Phys. Chem. Solids (GB), Vol. 18, No. 4, 290-6 (March, 1961).

Enthalpies and entropies of vacancy formation and diffusion ere calculated for elements having the diamond structure. In the alculations, the potential between nearest neighbour atoms is ssumed to have the form of the Morse function. In this fashion inetic parameters of crystals are calculated by the use of properties etermined from equilibrium properties. One of the factors facilit-ting calculation results from the open nature of the diamond lattice. ecause of this, an atom, moving from its equilibrium position into vacancy, does not pass through a geometric barrier as is the case r more close-packed structures. Calculations yield values for the nthalpies of formation of vacancies of 2.07, 2.32 and 4.16 eV for ermanium, silicon and diamond respectively. Experimental results vailable for germanium yield 2.01 eV. Calculations of the activa-ion enthalpies of self-diffusion, assuming a vacancy mechanism, re 3.02, 3.38 and 6.18 eV for germanium, silicon and diamond. xperimental information for germanium indicates a value of .98 eV.

19765 MOBILITY OF VACANCY PAIRS IN IONIC CRYSTALS. K.Tharmalingam and A.B.Lidiard.

hil. Mag. (GB), Vol. 6, 1157-62 (Sept., 1961).

Calculations were made of activation energies for vacancy-pair novements in NaCl and KCl using the approximation of a static attice. The numerical results indicate that these energies are omparable with or greater than the activation energies for single acancy movement. Qualitative reasons are given showing why this hould be so.

19766 ELASTIC DISPLACEMENT FIELD OF SINGLE AND DOUBLE FORCES IN ANISOTROPIC MEDIA.

.Mann, R.v.Jan and A.Seeger.
hys. Status solidi (Germany), Vol. 1, No. 1, 17-29 (1961).
n German.

The theoretical treatment of point defects in crystals requires a knowledge of the elastic displacement field of double forces. This displacement can be obtained by differentiating the elastic fundamental integral, i.e. the displacement due to a single force. Solutions in closed form, however, are only available for isotropic or hexagonal media. The present paper evaluates numerically Fredholm's implicit solution in the case of copper for single and double forces. In addition, an analytical treatment of the double force problem is given in terms of an expansion into spherical harmonics. It is discussed how the coefficients in the expansion must be determined for optimal approximation to the exact solution. The results of the first and second approximation are compared with the exact figures.

VACANCY DIFFUSION IN Mn AND Ni FERRITES.
See Abstr. 20137

19767 EFFECT OF INTERSTITIAL Li ON THE DENSITY OF Si. J.S.Prener and F.E.Williams.

J. chem. Phys. (USA), Vol. 35, No. 5, 1803-8 (Nov., 1961).

The densities of silicon and of silicon containing interstitial Li^+ were determined. There is a volume expansion of 4.7×10^{-24} cm^3 Li^+ dissolved in silicon. This expansion is interpreted as arising from the Coulombic repulsion between the Li^+ and the partially shielded Si^{4+} cores. Calculations based on a simple model of the charge distribution in silicon are in accord with this interpretation. The density change accompanying the room temperature deionization and aggregation of the lithium was also measured. During the initial stages of this process, the volume increases linearly by 6.0×10^{-24} cm^3 per lithium transferred from the ionized to the deionized state. This expansion is interpreted as arising from overlap repulsive forces between the Si and aggregates of neutral lithium in neighbouring interstitial sites. Considerations based on the size of Li^0 in these aggregates and the free energy change for the deionization and aggregation process support this interpretation. A final nonlinear region in the observed volume expansion is interpreted as being due to the precipitation of lithium metal so as to leave itself and the silicon strain free.

19768 INFLUENCE OF IMPURITIES ON THE DENSITY OF SINGLE CRYSTALS OF LiF.

B.P.Aleksandrov and G.A.Andreev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2445-50 (Aug., 1961).
In Russian.

Using a flotatron method for measuring density, it is shown that small amounts of Na, K, Ca, Ba, Fe, Ni, Al and Mn fluorides do not influence the density of LiF. Small amounts of MgF_2 increase the density, whereas LiOH, Li_2Co_3 and $LiNO_3$ decrease it. The results are discussed in relation to the miscibility and ionic radii of the components. [English translation in: Soviet Physics—Solid State (USA)]. R.F.S.Hearmon

19769 PHENOMENOLOGY OF IMPURITY CONDUCTION IN SEMICONDUCTORS. E.C.McIrvine.

J. Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 356-8 (Oct., 1960).

It was found that a critical impurity concentration, N_C, exists above which temperature independent impurity conduction in semiconductors is observed. It is shown that the phenomenological relation $N_C = (2.2\ a_H)^{-3} \exp(1-\epsilon)$, where a_H is the hydrogenic Bohr radius, and ϵ the static dielectric constant of the pure host material, fits the observed data for a wide range of materials from p-type Mg_2Sn ($N_C \sim 10^{16}$ cm^{-3}, $\epsilon = 19$) to n-type SiC ($N_C \sim 10^{20}$ cm^{-3}, $\epsilon = 10.0$). C.H.Gooch

19770 THE STRUCTURE OF NICKEL DEPOSITS BY CATHODE SPUTTERING. F.Gärtner.

Z. Naturforsch. (Germany), Vol. 16a, No. 8, 840 (Aug., 1961).
In German.

An experimental investigation of the influence of nitrogen upon the structure of nickel deposits. It is proved that some apparently anomalous structures are in fact nitrides. T.C.Toye

DEFECT STRUCTURE OF CADMIUM OXIDE CONTAINING FOREIGN ATOMS. See Abstr. 20535

ROLE OF FRENKEL DEFECTS IN FORMATION OF Ta_2O_5 ANODIC FILMS. See Abstr. 20675

19771 HARDENING DUE TO THE RECOMBINATION OF DISLOCATIONS. G.Saada.

Acta metallurgica (Internat.), Vol. 8, No. 12, 841-7 (Dec., 1960). In French.

Two simplified models were studied which show how the recombination of dislocations influences hardening. It was also established that, in a dislocation "forest", the piercing of attracting "trees" results in stresses which are decidedly greater than those accompanying the penetration of repulsing "trees". The recombination mechanism is responsible for the formation of vacancies of interstitials; the role played by thermal activation being negligible. It is supposed that the dislocations are not dissociated.

19772 DISLOCATIONS AND IMPURITY BOUNDARIES IN ZINC CRYSTALS GROWN FROM THE MELT.

V.V.Damiano and G.S.Tint.

Acta metallurgica (Internat.), Vol. 9, No. 3, 177-83 (March, 1961).

The distribution of etch pits at microsegregations produced by constitutional supercooling was investigated using progressive polishing and etching techniques. Crystals which exhibit an elongated cellular segregation structure commonly called "corrugation" structure have associated with them rows of etch pits. The density of etch pits, their rearrangement into walls and their formation into networks behind the interface suggests that the etch pits reveal the ends of decorated dislocations introduced at the segregation boundaries to accommodate the lattice strain. Networks form when the dislocations are set free as homogenization occurs behind the solid--liquid interface. The dislocations then become arranged into walls perpendicular to the $\{0001\}$. This secondary substructure fully developed 3 mm behind the solid—liquid interface increases in size as the crystal continues to grow and the dislocations climb and glide in agreement with predictions made by Tiller (Abstr. 9120 of 1958).

19773 SUBSTRUCTURES AND DISLOCATIONS PRODUCED DURING SOLIDIFICATION OF ALUMINUM.

H.Biloni.

Canad. J. Phys., Vol. 39, No. 10, 1501-7 (Oct., 1961).

The substructure and the dislocation arrangement produced during polycrystalline solidification of 99.99% aluminium was studied using the decanting method for the interruption of the solidification. Etching techniques to reveal individual dislocations and the method of thin epitaxial layers of aluminium oxide to reveal changes in impurity concentration were employed simultaneously. The development of the structure towards the interior of the solid was studied by successive electrolytic polishings. In this way it was possible to show that the "cell substructure" formed by dislocations originates in areas where "microsegregation" of impurities has occurred. Towards the interior of the solid a dislocation rearrangement into a "macromosaic" substructure which is closely related to the cellular susbstructure occurs. At the same time a substructure of "macrosegregation" occurs, arising from the original grain boundaries. The results are interpreted in the light of recent theories of solidification.

19774 VELOCITY OF SLOWLY MOVING DISLOCATION.

T.Takeuchi.

J. Phys. Soc. Japan, Vol. 16, No. 9, 1682-5 (Sept., 1961).

It is assumed that the observed dislocation velocity is the average velocity during successive jumps, and that the jumping distances are large compared with the atomic spacing. The excitation probabilities for large jumps are calculated by the forces of dislocation, in which thermal effects are introduced as fluctuations of the local shear stress. The dislocation velocity in otherwise perfect crystals of relatively large Peierls stress are obtained-ed as the functions of applied stress and temperature.

19775 SCREW DISLOCATION IN CRYSTALS WITH DIAMOND STRUCTURE. V.Celli.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 100-4 (April, 1961).

The model of dislocation in a lattice proposed by Maradudin (Abstr. 8814 of 1959) is modified and applied to an estimate of the strain energy of a screw dislocation in crystals with the diamond structure, in particular Si and Ge.

19776 DISLOCATIONS IN VISCOELASTIC MATERIALS.

J.D.Eshelby.

Phil. Mag. (GB), Vol. 6, 953-63 (Aug., 1961).

An expression is found for the force required to move a dislocation steadily through a viscoelastic medium, in particular Zener's standard linear solid. It is applied to the case of a screw dislocation in iron exhibiting the Snoek effect. Schoeck and Seeger atomic treatment of the same problem (Abstr. 15848 of 1960) contains an error. When this is corrected the two methods give solutions of the same form.

19777 ON THE ANNEALING OF PRISMATIC DISLOCATION LOOPS IN ALUMINIUM.

F.Kroupa, J.Silcox and M.J.Whelan.

Phil. Mag. (GB), Vol. 6, 971-8 (Aug., 1961).

A recently proposed mechanism for coalescence of dislocation loops on annealing by a pipe diffusion mechanism is examined. Th driving force for pipe diffusion arises from two sources. In the first, differences in concentrations of vacancies round the perimeter of a loop due to differences in the forces exerted by a neighbouring loop cause a net flow of vacancies tending to make the loops coalesce. In the second, vacancies, formed at a given loop, interact with the stress field of a neighbouring loop. The driving forces for both these processes seem to be of the same order of magnitude, and the dependence on separation of the loops is similar. Estimates of the driving force are made from the stress field of a prismatic loop. The driving force is very small owing to the rapid decrease of the stress field with distance from a prismatic loop. It is shown that the times of coalescence of typical neighbouring loops are much longer than those recently proposed. It is concluded that pipe diffusion cannot be the rate-controlling mechanism for annealing of loops in quenched aluminium.

19778 OBSERVATIONS ON CHARGED DISLOCATIONS IN IONIC CRYSTALS.

J.Vennik, G.Remaut and W.Dekeyser.

Phil. Mag. (GB), Vol. 6, 997-1001 (Aug., 1961).

Further results concerning charged dislocations in NaCl and LiF are described. These observations differ from those published earlier (Abstr. 7917 of 1960; 5043, 14933 of 1961) owing to the fact that the duration of the deformation pulses could be changed. It was found that in most of the specimens the dislocations were negatively charged and a "barrier formation" is described. A second series of experiments with an Instron testing machine showed that an electrical effect could be obtained in the elastic region of the specimen.

19779 A DISLOCATION AT A FREE SURFACE.

E.H.Yoffe.

Phil. Mag. (GB), Vol. 6, 1147-55 (Sept., 1961).

The stress field of a dislocation meeting a free surface of an elastic body is calculated for any angle of incidence and any Burgers vector.

19780 THE OCCURRENCE OF DISLOCATIONS IN CRYSTALS GROWN FROM THE MELT. S.Howe and C.Elbaum.

Phil. Mag. (GB), Vol. 6, 1227-40 (Oct., 1961).

Single crystals of aluminium were grown by the Czochralski method at various rates. The crystals were carrot-shaped, about 4 cm long, tapering from a diameter of about 3 mm at the top to about 0.1 mm at the bottom. X-ray diffraction micrographs were taken of these specimens by means of Lang's technique, which is capable of revealing the dislocation structure in the interior of a crystal. It was found that the density of dislocations present in an as-grown crystal increases with both increasing diameter and rate growth. For sufficiently small diameters (below about 0.3 mm) it was possible to grow crystals free of detectable dislocations. Thes experimental results are consistent with the idea that the majority of the initial dislocations are produced by the collapse of vacancy discs that are nucleated when a sufficient supersaturation of vacancies is reached in the crystal. Theoretical calculations of the supersaturation of vacancies that arise during crystal growth were made by considering the diffusion of these imperfections in a specimen cooled from the melting temperature. It is shown that the range of diameters below which the vacancy supersaturation is too small to nucleate a dislocation is of the same order of magnitude as the diameters of crystals found that contain no detectable dislocations.

19781 THE FORCE ON A MOVING DISLOCATION.

F.R.N.Nabarro.

Phil. Mag. (GB), Vol. 6, 1261-6 (Oct., 1961).

There is a close formal similarity between the equations of elasticity with anti-plane strain and the equations of electrodynamic two dimensions, the screw dislocation being the counterpart of the e charge. This similarity has led to the suggestion that there is a ecific "Lorentzian" force on a dislocation which moves through a dium which is itself in motion. This is the analogue of the mag- ic force on a moving charge. The equations of a linear continuum n be satisfied whether such a force exists or not. A nonlinear del based on that of Peierls is constructed, and an approximate lution of a problem is presented which, if the approximations made e justified, demonstrates that this "Lorentzian" force on a dislo- tion does not exist.

19782 ELASTIC SELF- AND INTERACTION ENERGIES OF DISLOCATION JOGS. F.Kroupa and L.M.Brown.

il. Mag. (GB), Vol. 6, 1267-70 (Oct., 1961).

An elastic calculation shows that there is an interaction between o jogs or kinks on an infinite straight dislocation line. For jogs fficiently far apart, the interaction potential varies as the recipro- l of the distance between them, and as the product of their lengths. rmulae are also obtained for the self-energies of jogs.

19783 A CRYSTAL DISLOCATION PROBLEM. R.A.Rankin.

roc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 4, 898-9 (Oct., 1961).

A theoretical analysis is given to show that for any lattice ere are only a finite number of slip vectors and they can be found y examining those points of the lattice that lie inside or outside a ertain sphere. C.A.Hogarth

EFFECT OF APPLIED FORCES ON DISLOCATIONS ORMING A TILT BOUNDARY. See Abstr. 20328

19784 THE OBSERVATION OF DISLOCATIONS IN MICA. E.C.H.Silk and R.S.Barnes.

cta metallurgica (Internat.), Vol. 9, No. 6, 558-62 (June, 1961).

Thin cleaved fragments of mica which have been examined in e electron microscope contained dislocations lying in the cleavage lanes. These dislocations, which are formed by slip, interact imply. The superposition of loose sheets of the mica produced oiré patterns which revealed those dislocations which were erpendicular to the cleavage plane.

19785 THE OBSERVATION OF DISLOCATION MOVEMENT IN α-IRON WITH THE ELECTRON MICROSCOPE.

L.G.Orlov and L.M.Utevskii.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3242-6 (Oct., 1961). In Russian.

Thin foils of α-iron were prepared from 50 μ sheets by electro-polishing in a mixture of acetic and hydrochloric acids. Transmission electron microscopy was used to study the movement of dislocations directly and to determine the crystallographic elements of glide. Slip normally occurred on $\{110\}$ planes with a Burgers vector of the type $\frac{1}{2}[111]$, and cross-slip on $\{211\}$ planes was also observed. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Barber

19786 DISLOCATION IMAGES IN PURE IRON OBSERVED BY TRANSMISSION ELECTRON MICROSCOPY.

H.Fujita and Z.Nishiyama.

J. Phys. Soc. Japan, Vol. 16, No. 10, 1893-1909 (Oct., 1961).

The dislocation image has a line or dotted feature, which depends essentially upon the reflecting condition. This dependence was clarified by the dark field image method and also by the method of small variation of the incident angle of the electron beam. (a) Line images of dislocations: (1) Generally the contrast of the dislocation image near an extinction contour is mainly due to the reflection of the same index as that of the contour; (2) The dislocation image usually appears as a single line, but sometimes as a double image, when it is due to one reflection; (3) Conversely, sometimes the image looks like a single line even when it is due to multiple reflections; (4) The image having black contrast is generally accompanied by white side-lines, and when the latter predominate the image is observed as a white dislocation image; (5) Near the intersection of dislocations of two families, there are found some variations in the image features which may be not only due to the interaction between strain fields of the intersecting dislocations, but also due to the systematic interaction of the reflections. (b) Dotted images of dislocations: (1) Each dot in the dotted images is frequently composed of the white and the black regions lying side by side and distributed alternately along the dislocation line; (2) The zig-zag image is considered as a special feature of the dotted image, which is occasionally produced by two reflections; (3) Complex features of the dotted images, for instance, the image interposed between two black lines, are due to multiple reflections. Finally, it is shown that the foil is bent by the dislocation to relieve the dislocation stress, and that some of the image features may be affected by this phenomenon because of variation of the reflecting condition.

19787 THE ELECTRON-MICROSCOPE OBSERVATION OF ELEMENTARY GLIDE STEPS ON NaCl CRYSTALS.

H.Bethge and W.Keller.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 8, 470-4 (1960). In German.

Demonstrates the possibility of observing in an electron microscope the interaction of an edge dislocation with a screw dislocation using the decoration technique. Assuming, after Griffin, that the steps of the screw dislocation are of unit lattice spacing, an argument is illustrated for a similar height of edge glide planes. V.R.Switsur

19788 THE DIRECT OBSERVATION OF LATTICE DEFECTS BY FIELD ION MICROSCOPY. D.G.Brandon and M.Wald.

Phil. Mag. (GB), Vol. 6, 1035-44 (Aug., 1961).

Observations of Mo and W in the field ion microscope revealed the structure of edge dislocations and a grain boundary in molybdenum. Tungsten was irradiated with 5 MeV α-particles and the production of vacancies at the surface observed. It is shown that this technique can be used to investigate the atomic structure at a grain boundary and around the core of a dislocation while it can be applied to the study of radiation damage to give information about the distribution and range of the damage produced by a single high-energy impact.

19789 THE OBSERVATION OF DISLOCATIONS TO ACCOMMODATE THE MISFIT BETWEEN CRYSTALS WITH DIFFERENT LATTICE PARAMETERS. J.W.Matthews.

Phil. Mag. (GB), Vol. 6, 1347-9 (Nov., 1961).

A thin (800 to 1000 A) foil, composed of a single-crystal layer of PbS and a similar layer of PbSe, was prepared by an evaporation technique. The crystals were in parallel orientation and the interface between them was parallel to (001). The foil was examined in a transmission electron microscope and a square grid of dislocations to take up the misfit between the two lattices was observed. The dislocations were of edge type and their Burgers vectors were $\frac{1}{2}a\ \langle 110\rangle$.

19790 DISLOCATIONS IN CALCITE CRYSTALS. II. INFORMATION FROM ETCH-SENSITIVE DISLOCATIONS AND THEIR DISTRIBUTION IN THE REGION OF SCRATCH-LINES AND PRESSURE-MARKS ON RHOMBOHEDRAL CLEAVAGE FACES. I.Hanke.

Acta phys. Austriaca, Vol. 14, No. 2, 115-39 (1961). In German.

For Pt I see Abstr. 11532 of 1961. Systems of etch-pits around scratches on calcite crystal faces have been shown up by etching with dilute acetic acid. Photographs, in phase contrast or interference, are reproduced. A.R.Stokes

19791 DISLOCATION ETCH PITS IN POLISHED LEAD TELLURIDE. G.P.Tilly.

Brit. J. appl. Phys., Vol. 12, No. 9, 524 (Sept., 1961).

Describes a procedure for revealing dislocation pits, subgrain structure, and deformation patterns, by electrolytic followed by chemical etching. C.A.Hogarth

19792 DISLOCATION ETCHING SOLUTION FOR POTASSIUM CHLORIDE AND OTHER ALKALI HALIDES. J.S.Cook.

J. appl. Phys. (USA), Vol. 32, No. 11, 2492 (Nov., 1961).

Propionic acid containing 1.75% by weight of barium followed by petroleum ether as a rinse is found to give excellent results. C.A.Hogarth

19793 ETCH PITS ON X-RAY DAMAGED ROCHELLE SALT. K.Okada.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1647-8 (Aug., 1961).

In Rochelle salt open-cored dislocations (sudarés) running parallel to the c-axis are found; etching can reveal these as pits. X-ray damaged crystals show etch pits of hip roof shape with ridges along the a-direction. Sudarés seen as fine lines on a-plates and as bright spots on c-plates are arranged in a plane perpendicular to the b-axis and correspond to the hip roof etch pit.

C.A.Hogarth

19794 EXPERIMENTS ON THE ETCHING OF ZINC SINGLE CRYSTALS. V.M.Kosevich and V.P.Soldatov.
Kristallografiya (USSR), Vol. 6, No. 4, 439-42 (May-June, 1961).
In Russian.

A number of etchants were tried for revealing the deformation pattern in the basal plane of zinc single crystals. The etchants may be divided into three groups: (1) those which produce oriented precipitates; (2) those which oxidize the surface; and (3) those which etch the dislocation defects. Dislocation formation in direct and back twinning was studied. Slip distribution in twin lamellae is explained. [English translation in: Soviet Physics—Crystallography (USA), Vol. 6, No. 3, 347-50 (Nov.-Dec., 1961).

19795 ETCHING EXPERIMENTS ON SYNTHETIC QUARTZ. G.Gülzow-Qual.
Phys. Status solidi (Germany), Vol. 1, No. 1, 62-7 (1961). In German.

A description is given of etching experiments on synthetic quartz to investigate the relation between etching cavities and certain growth-conditioned irregularities of the crystal. By a prolonged etching process, hollow channels are produced at many etching cavities and lead to inclusions and hollow spaces. These so-called etching channels are likely to develop at dislocations; inclusions and cavities may also give rise to them.

19796 MECHANICAL AND RADIATION INDUCED FAULTING IN SODIUM AZIDE. D.T.Keating and S.Krasner.
J. Phys. Chem. Solids (GB), Vol. 20, No. 1-2, 150-61 (June, 1961).

Sodium azide powders subjected to mechanical grinding, gamma irradiation, and pile irradiation were examined by X-ray diffraction techniques. Faulting and strain are found in the ground samples with no indication of decomposition. Faulting and strain are also found in samples subjected to irradiation accompanied by signs of decomposition such as coloration, lowering of the ignition temperature, and a lattice contraction in the direction of the long dimension of the azide ion. Annealing removes some of the faults and strain both in the ground and irradiated samples, but in the latter cases a significant fraction of these imperfections are stable even at the ignition temperature. The two types of irradiation produce qualitatively similar results, and quantitative differences are ascribed to the more inhomogeneous decomposition induced by pile irradiation. In both cases a return to stoichiometry upon annealing is evidenced by a disappearance of the lattice contraction.

19797 DIRECT MEASUREMENTS OF STACKING-FAULT ENERGIES FROM OBSERVATIONS OF DISLOCATION NODES. A.Howie and P.R.Swann.
Phil. Mag. (GB), Vol. 6, 1215-26 (Oct., 1961).

From measurements of the radius of curvature of extended dislocation nodes observed by transmission electron microscopy, stacking-fault energies were determined for a number of copper- and silver-based—aluminium and zinc solid-solution alloys and also for a number of nickel—cobalt alloys. Rough estimates of about 40, 25 and 150 erg cm^{-2} respectively can be made of the stacking-fault energies of copper, silver and nickel. The accuracy of the measurement and the possibility of segregation of solute atoms to stacking faults are discussed.

THE ELECTRICAL RESISTIVITY OF STACKING FAULTS AND LATTICE VACANCIES IN GOLD. See Abstr. 19832

19798 PROBLEM OF SPIRAL-LAYER EVAPORATION IN CRYSTALS. E.D.Dukova.
Kristallografiya (USSR), Vol. 6, No. 3, 451-4 (May-June, 1961).
In Russian.

The dependence of the normal rate of formation of a spiral evaporation pit on the degree of unsaturation was measured. The layer separation process of an evaporation spiral was recorded, and increase in the normal evaporation rate discovered. The evaporation rate at a dislocation centre is calculated by means of Cabrera's formula and compared with experimental results. The conclusion is drawn that the mechanism responsible for the formation of a spiral evaporation pit is the process of the layer separation of the evaporation spiral. [English translation in: Soviet Physics—Crystallography (USA), Vol. 6, No. 3, 357-61 (Nov.-Dec., 1961)].

Diffusion

19799 DIFFUSION IN HETEROGENEOUS MEDIA: LATTICES OF PARALLELEPIPEDS IN A CONTINUOUS PHASE.
R.M.Barrer and J.H.Petropoulos.
Brit. J. appl. Phys., Vol. 12, No. 12, 691-7 (Dec., 1961).

A treatment is given of the permeability of a heterogeneous medium consisting of a regular lattice of rectangular parallelepipe in a continuum. Effects on the permeability due to surface resistances on the upstream and downstream faces of the parallelepiped were considered, and also aspects of the role of particle shape and orientation. The treatment provides an approach to the permeability of and fractionation by foam plastic membranes. When the disperse phase has molecular sieve properties, high continuous fractionation factors for appropriate composite membranes and mixutures of diffusants are found to be possible. The treatment is also valid for the thermal or electrical conductivity, permittivity, or magnetic permeability of such a lattice.

19800 THE DEPENDENCE OF DIFFUSION AND PERMEATIO OF GASES IN HIGH POLYMERS ON CRYSTALLINITY AND ON TEMPERATURE. D.Jeschke and H.A.Stuart.
Z. Naturforsch. (Germany), Vol. 16a, No. 1, 37-50 (Jan., 1961).
In German.

Permeability, diffusion and solubility coefficients of permanent gases (He, H_2 and N_2) were measured for terylenes and polypropylenes of different crystallinities. All three quantities decrease markedly on crystallization, to extents dependent on the gas and on the temperature. It follows that in respect of diffusion and sorption the partly crystalline polymer cannot be treated as a two-phase system consisting of an amorphous, permeable, phase and an impermeable, crystalline phase. The activation energies for diffusion and for permeation also fall on crystallization: there is therefore not simply a reduction of the phase responsible for transport on crystallization but a change in character. It is suggested that in completely crystalline polymers diffusion takes place by way of lattice defects and grain boundaries, in which the mobility of chains is smaller than in the amorphous material.

R.F.Barrow

19801 AN INVESTIGATION OF ELECTRICAL TRANSPORT IN METALS AND SEMICONDUCTORS UNDER THE ACTION OF THE HALL ELECTRIC FIELD. Yu.G.Miller.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2383-9 (Aug., 1961).
In Russian.

A method is described for determining the charge on ions in metals, semiconductors, and alloys, based on the study of electric transport in a transverse Hall electric field. This excludes the effect of the transfer of the extra momentum of the conduction electrons in a field. As examples it was shown that iron diffuses through germanium as trivalent positive ions (experiment at 825° C) and that carbon is positively charged in a solid solution of α-iron (experiment at 800° C). [English translation in: Soviet Physics—Solid State (USA)].

R.Berma

A NOTE ON THE ELECTRON DIFFUSION AND THE WALL RELAXATION IN FERRITES. See Abstr. 20126

DIFFUSION IN POROUS MEDIA. See Abstr. 20649

19802 DIFFUSION OF SILVER, COBALT AND IRON IN GERMANIUM. L.Y.Wei.
J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 162-74 (Feb., 1961).

In investigations by radiotracer techniques it was found that: (1) in most cases, the concentration varies as $\exp(-x/L)$ rather than the Gaussian or error function as usually expected from Fick's (second) law; (2) the diffusivities of these elements in Ge are in the range 10^{-6}-10^{-7} cm^2/sec at temperatures around 800°C and the values are higher in low dislocation (less than 10^3 pits/cm^2) than in high dislocation (around 10^5 pits/cm^2) crystals; (3) the solubilities o Ag, Co and Fe in Ge are very low, in the range 10^{-8}-10^{-9} in atomic fraction; (4) the activation energy of Co diffusion in Ge is about 1 eV nearly the same as those of Ag, Ni and Fe diffusion as obtained by other workers. It is suggested that the anomalous diffusion is due t a double stream process which is composed of free species and trapped ones. This trapping mechanism not only leads to a concentration varying approximately as $\exp(-x/L)$ but also offers reasonable explanations for many other experimental facts.

9803 THERMAL DIFFUSION OF THE Li ISOTOPE IN SOLID LITHIUM SULPHATE. K.Lindqvist and A.Lundén.

Naturforsch. (Germany), Vol. 16a, No. 6, 626-7 (June, 1961).
erman.

The thermal diffusion of the light isotope of lithium from the hot of a solid specimen of lithium sulphate was measured. In spite he high self-diffusion of Li in cubic Li_2SO_4, the stationary configu- ion was reached after a few days. The Soret coefficient (ratio of rmal to self-diffusion coefficients) was found to be (7.8 ± 0.9) × 0^{-5} deg^{-1} for the range of 600-830°C. C.A.Hogarth

9804 SURFACE SELF-DIFFUSION MEASUREMENTS ON NICKEL BY THE MASS TRANSFER METHOD.

M.Blakely and H.Mykura.
ta metallurgica (Internat.), Vol. 9, No. 1, 23-31 (Jan., 1961).

Surface self-diffusion constants D_S for nickel, heated in vacuo temperatures between 800°C and 1200°C, were calculated from erferometric measurements of the rate of smoothing of scratches. was found to depend strongly on surface orientation, the effect ing greatest at the lower temperatures. This is ascribed largely orientation dependent impurity adsorption. The formation of ts of exact (111) and (100) orientations was observed indicating ich higher values of D_S for these planes. Impurity adsorption as found to be least for surfaces near (111). The variation of ffusion constant with temperature for surfaces oriented within ° of the (111) surface was given by $D_S = D_0 \exp(-Q/KT)$ with $= 5(\pm 3) \times 10^{-4}$ cm^2/sec and Q = 0.62 (±0.08) eV.

19805 DIFFUSION OF SILVER ON GERMANIUM SURFACES. V.E.Kosenko and L.A.Khomenko.

iz. tverdogo Tela (USSR), Vol. 3, No. 10, 2967-72 (Oct., 1961).
Russian.

The surface diffusion of activated silver on {111} surfaces of rmanium monocrystals was measured in the temperature range 0°-700°C. Germanium samples of resistivity about 30 ohm cm ere mechanically polished and lightly etched or chemically olished, and diffusion took place in a vacuum of 10^{-5} mm Hg. The tivation energy for diffusion was the same for both surface treat- ents, but diffusion was ~ 5 times faster on mechanically polished nd etched surfaces, for which D_S is given as $5.4 \times 10^{-4} \exp(-0.37/kT)$ o units stated]. D_S is 10^{-5} cm^2/sec at 1000°K and about 0^{-7} cm^2/sec at 500°K. The results are interpreted in terms diffusion in a mechanically disturbed layer whose depth would ary from 10^{-2} cm at 1000°K to 10^{-4} cm at 500°K. [English anslation in: Soviet Physics—Solid State (USA)]. G.Wyllie

19806 THE DIFFUSION CONSTANTS OF THALLOUS (Tl^+) AND LEAD (Pb^{++}) IONS IN POTASSIUM CHLORIDE.

.Glasner and R.Reisfeld.
. Phys. Chem. Solids (GB), Vol. 18, No. 4, 345-55 (March, 1961).

Diffusion constants of monovalent thallium and divalent lead nto potassium chloride (in the low temperature range of the latter) ere evaluated by a new spectral method. Q, the activation energy f thallium ions, was found to be somewhat greater than that of the ead ions, the latter being about equal to the activation energy of he self-diffusion of the potassium ions. It is suggested that the omparatively small pre-exponential factor D_0 for lead is due to ts formation of complexes with cation vacancies. The results ob- ained on heating the pressed disks differed widely from those with the mixed powders. The difference is accounted for by assuming a revalence of "gain boundary diffusion" in the pressed disks, whilst "volume diffusion" is deactivated by the high pressure pre- iously applied. The energy of activation with pressed disks is found to be about 10% larger than the latent heat of fusion of the salts employed, namely thallium chloride and thallium sulphate.

19807 THE EFFECT OF FATIGUE STRESSING ON THE DIFFUSION RATE OF ZINC IN ALUMINIUM.

S.Pearson, A.J.Board and C.Wheeler.
Phil. Mag. (GB), Vol. 6, 979-85 (Aug., 1961).

Experiments were made to find the effect of fatigue stressing on the diffusion rate of zinc in aluminium and in an aluminium—20% zinc alloy. Diffusion measurements were made on unstressed specimens and on specimens which were being fatigued in the temperature range 300°C-375°C. The results show that only small changes, at most, were produced in the diffusion rates despite the very high plastic strain rates (approximately 144 per hour) given by the fatigue stressing.

EFFECT OF SILVER ON THE ENERGY SPECTRUM OF COPPER OXIDE. See Abstr. 19876

Colour Centres

19808 COLORATION SPECTRA OF STRONTIUM FLUORIDE SINGLE CRYSTALS. H.Karras.

Phys. Status solidi (Germany), Vol. 1, No. 1, 68-80 (1961).
In German.

The spectra of subtractive and additive coloration of strontium fluoride were measured; reproducible types of spectra were obtained. Pure crystals could be coloured only slightly by X-rays. After additive coloration, they exhibited an absorption spectrum which could be regarded as typical of the intrinsic defects. Addition of oxygen altered the absorption spectrum before and after coloration; the coloration spectra found were quite different from those of the intrinsic defects.

ABSORPTION OF THE DEFECTS IN SILVER BROMIDE WITH THE ADDITION OF DIVALENT IMPURITY IONS. See Abstr. 19968

19809 A STUDY OF THE EFFECT OF γ-IRRADIATION ON PHOSPHATE GLASSES BY THE METHOD OF ELECTRON PARAMAGNETIC RESONANCE.

G.O.Karapetyan and D.M.Yudin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2827-34 (Sept., 1961).
In Russian.

It has been previously proposed that colour centres in phosphate glasses were essentially electrons and holes trapped at oxygen vacancies near alkali ions. The present work shows, that in fact, localization occurs at phosphorus atoms. The glasses studied were produced in an oven which could be maintained under either reducing or oxidizing conditions. The absorption spectrum and the electron paramagnetic resonance spectrum were both recorded at room and liquid nitrogen temperatures. The specimens were given doses of γ-rays, in the range 10^5-10^6 rontgens. The experimental results lead to models for the colour centres, which are essentially connected with the structure of the glass. It is proposed that PO_4 groups capture those electrons which do not recombine with holes, and the experimental results are satisfactorily explained on the basis of such a proposal. [English translation in: Soviet Physics—Solid State (USA)]. M.N.Rudden

19810 STRUCTURE AND PROPERTIES OF A-CENTERS IN KCl. K.Kojima, N.Nishimaki and T.Kojima.

J. Phys. Soc. Japan, Vol. 16, No. 10, 2033-44 (Oct., 1961).

In additively coloured KCl crystals containing sodium, irradiation in the F-band causes its complete conversion into two absorption bands which are termed A_1 and A_2. By investigating their thermal, photochemical, and dichroic properties, these two bands are found to arise from a common species of centres called A-centres, and are identified with Petroff's A- and B-bands which have been found in nominally pure specimens. From the analysis of dichroic spectra, peak energy and half-width are determined for each band at several temperatures. The observed oscillator strength is 0.90 for the A_1-band and 0.81 for the A_2-band. The A-centres are destroyed thermally with an activation energy 0.43 eV. A model is proposed for the A-centre whereby it consists of an F-centre having a sodium ion as nearest neighbour to the vacancy. A calculation of energy levels by the method of molecular orbitals is presented.

19811 PROPERTIES OF LITHIUM HYDRIDE. III. PARAMAGNETIC RESONANCE OF COLOR CENTERS.

W.B.Lewis and F.E.Pretzel.
J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 139-46 (April, 1961).

For Pt II, see Abstr. 17578 of 1961. Concentrations of F-centres in excess of $10^{17}/cm^3$ were produced in single crystals of LiH by neutron irradiation at 78°K. The ESR absorption of the F-centres was observed at g = 2.004 ± 0.001. The saturation parameter of the ESR absorption $(T_1T_2)^{1/2}$ is close to that for F-centres in KCl. From r.m.s. line width measurements on LiH crystals of various isotopic compositions (Li^7H, Li^7D, Li^6H and Li^6D), spin densities of the F-centre electron at the Li^+ and H-sites were estimated.

PARAMAGNETIC RESONANCE OF THE ANTIMORPH OF THE F-CENTRE. See Abstr. 20217

ELECTRON SPIN RESONANCE IN F^--CENTRES. See Abstr. 20222

SPIN—LATTICE RELAXATION OF LOCALIZED ELECTRONIC CENTRES. See Abstr. 20242

19812 THE ELASTIC SCATTERING OF A NON-LOCALISED EXCITON ON U-CENTRES. Z.S.Kachlishvili.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2864-6 (Sept., 1961). In Russian.

This work continues previous investigations as described in Abstr. 10015 of 1961. A general formula for the cross-section for elastic scattering σ, on the U-centre is derived and applied to the particular case of NaCl. It is found that $\sigma = 6.3 \times 10^{-15}$ cm^2. [English translation in: Soviet Physics—Solid State (USA)] .
M.N.Rudden

19813 HAS THE M CENTRE IN KCl A MAGNETIC MOMENT? H.Gross.
Z. Phys. (Germany), Vol. 164, No. 3, 341-58 (1961). In German.

Defect centres of M-type produced by F-centre irradiation at room temperature show no electron spin resonance signal. Three independent methods were used: (1) the spin resonance absorption was compared with the optically determined F-centre concentration before and after M-centre formation; (2) crystals having M-centres were examined for anisotropy of spin resonance; (3) spin resonance dispersion signals were measured and analysed for different microwave powers. It is concluded that the M-centre is diamagnetic, which negates the M-centre model of Seitz and Knox but supports that of van Doorn, Haven and Pick. G.F.J.Garlick

19814 ON THE R CENTERS IN LITHIUM FLUORIDE. A.Okuda.
J. Phys. Soc. Japan, Vol. 16, No. 9, 1746-62 (Sept., 1961).

In coloured LiF crystals, two bands at 320 and 378 mμ were investigated and assigned as R_1 and R_2 bands corresponding to R-bands in other alkali halides. The intensity ratio of the R_1 band to the R_2 band was almost constant irrespective of irradiation conditions of β- or γ-rays as well as of photochemical treatment. Both the bands were bleached by irradiation with either R_1 or R_2 light, and the former was found to have a higher efficiency for the bleaching. The results support the interpretation that R_1 and R_2 bands are due to transitions in the same centre. Emission spectra by excitation with R_1 and R_2 light are distinct: the latter has a peak at 495 mμ and the former at 730 mμ or above. By polarized R light, dichroism was induced into the R_1, R_2 and M bands and also polarization of the emissions was observed. Then symmetries of the models which have been proposed as complexes of F-centres are examined using the experimental results and it is considered that the F_3-model lying in the [111] plane is the most adequate for R-centres. In addition to characteristic M-centre luminescence, which has a peak at 710 mμ and value of 0.6 for P[011], an emission band at 525 mμ was observed by M-light excitation; but the P-factor for this emission is less than that for the M-centre luminescence.

19815 ANISOTROPIC COLOUR CENTRES IN KCl. C.Z.van Doorn and Y.Haven.
Ned. Tijdschrift Natuurkde (Netherlands), Vol. 26, No. 7, 216-20 (July, 1960). In Dutch.

Surveys the production of F and M centres in KCl crystals, their polarizing properties and luminescent behaviour. Various models are discussed. J.Thewlis

Radiation Effects

19816 ON THE THEORY OF RADIATION-INDUCED CHANGES IN METALS.
I.M.Lifshits, M.I.Kaganov and L.V.Tanatarov.
Atomnaya Energiya (USSR), Vol. 6, 391 (1959). In Russian.
English translation in: Reactor Sci. (GB), Vol. 12, No. 1-2, 69-78 (May, 1960).

The local heating caused by nuclear particles passing through matter is considered with due allowance for the interactions between lattice and electrons that equalize the temperatures of the two. Methods are developed for calculating the effective kinetic coefficients of fissile media. The effects of local heating on the mechanical properties are clarified.

RADIATION HARDENING OF COPPER SINGLE CRYSTALS. See Abstr. 20391

OBSERVATION OF α-RAY DAMAGE IN TUNGSTEN BY FIELD ION MICROSCOPE. See Abstr. 19788

19817 MOLECULAR DISARRAY IN A CRYSTAL LATTICE PRODUCED BY A FISSION FRAGMENT.
F.P.Bowden and L.T.Chadderton.
Nature (GB), Vol. 192, 31-4 (Oct. 7, 1961).

Crystals of platinum phthalocyanine up to 40 A in thickness we prepared for transmission electron microscopy by condensing the crystals directly on to the support films from the vapour phase. It was found possible to observe the molecular disarray produced in t crystal lattice when a single fission fragment passes through it. Th extent of the damage could be measured within one molecular plane and varies in extent between seven and twenty ($20\bar{1}$) planes, being dependent on where and at what angle, the fragment strikes the crystal. In some cases dislocation dipoles were formed. The method appears useful for studying the detailed mechanisms of radiation damage. R.Bullough

EFFECT OF γ-RAYS ON THE ELECTRICAL CONDUCTIVITY OF CdS. See Abstr. 19903

ULTRASONIC ABSORPTION IN FAST-NEUTRON IRRADIATED SiO_2 GLASS. See Abstr. 20634

19818 GAS BUBBLE FORMATION IN IRRADIATED PLASTICS AND REACTOR FUELS. G.G.Bentle.
Nuclear Sci. Engng (USA), Vol. 7, No. 6, 487-95 (June, 1960).

A transparent plastic in which gas was formed by gamma irradiation, was used to investigate the mechanisms of gas bubble formation and growth. Bubble formation and swelling were studied for several environments, both external and internal to the plastic-gas systems. During irradiation at 100°C, larger but fewer bubbles form in the plastic than on lower temperature irradiation followed by 100°C annealing. The data indicate that inclusions increase bubble formation and internal surfaces promote bubble growth. An interpretation of these results, when applied to nuclear fuel swelling, indicates that swelling may be decreased by increasing fission rate and by decreasing the available sites for bubble nucleation and growth.

19819 DISSOLUTION AND CONTACT MELTING OF IRRADIATED CRYSTALS.
I.G.Berzina, A.F.Naumov and N.A.Savintsev.
Kristallografiya (USSR), Vol. 6, No. 3, 460-4 (May-June, 1961). In Russian.

Descriptions are given of experiments with NaCl, Bi, Cd and Pb before and after exposure to X-rays or slow neutrons. The rates of the processes are found to be structure-sensitive. [English translation in: Soviet Physics—Crystallography (USA), Vol. 6, No. 3, 366-8 (Nov.-Dec., 1961)].

19820 LITHIUM PRECIPITATION IN SINGLE CRYSTALS OF LITHIUM FLUORIDE IRRADIATED BY THERMAL NEUTRONS. M.Lambert, C.Mazieres and A.Guinier.
J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 129-38 (Feb., 1961). In French.

Earlier X-ray diffraction results have shown that lithium precipitation occurs in lithium fluoride by radiation damage. Thin plates of atomic thickness were produced and for larger neutron doses, anomalous f.c.c. lithium appeared in epitaxy on the lithium fluoride lattice. By heating, this lithium was transformed into normal, b.c.c. lithium. These results are in good agreement with those found by a fundamentally different method, differential therma micro-analysis, and by means of this method and X-ray diffraction, the transformations of lithium inclusions on heating were studied.

19821 NEUTRON IRRADIATION OF Cu—Al AT ELEVATED TEMPERATURES. R.H.Kernohan and M.S.Wechsler.
J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 178-80 (Feb., 1961).

The effect on the electrical resistivity of Cu—Al (15 at.% Al) is described. The results support the idea that at temperatures below

0°C the alloy is in a metastable state. Upon irradiation atomic obilities are enhanced and the metastability is eliminated, accom- nied by a decrease in resistivity. An analysis is made of the tem- rature dependence of the rate of the atomic rearrangement stimu- ted by the irradiation. It is found that the activation energy for otion remains constant during the process at about 0.5 eV. A com- rison is made with the results of a previous experiment in which e alloy was irradiated at lower temperatures.

19822 EFFECTS OF FAST NEUTRON IRRADIATION ON THE STRUCTURE AND MAGNETIC PROPERTIES OF Ni HIN FILMS. I.Teodorescu and A.Glodeanu.
ev. de Physique (Roumania), Vol. 5, No. 3-4, 315-23 (1960).

The films were found to be transformed from the face-centred ıbic to the close-packed hexagonal phase during irradiation, the ansformation being the more complete the more intense the neutron ux. As a results of this transformation the saturation magnetization ecreases markedly. E.P.Wohlfarth

SURFACE HETEROGENEITY IN IRRADIATED SOLIDS. e Abstr. 20660

TRANSMITTANCE CHANGES IN GLASSES INDUCED BY LTRAVIOLET RADIATION. See Abstr. 19963

19823 SCATTERING OF LONG WAVE-LENGTH NEUTRONS BY IRRADIATED BERYLLIUM OXIDE.
.M.Sabine, A.W.Pryor and B.S.Hickman.
ature (GB), Vol. 191, 1385-6 (Sept. 30, 1961).

An investigation of the scattering of long wavelength neutrons as made on irradiated BeO at doses up to 6.8×10^{26} nvt and with eutron wavelengths of 4.5 – 8.0 A. The effect of annealing on the cattering of such neutrons was examined for annealing temper- tures from 27° to 1200°C. Models to explain the observed results are discussed. J.Thewlis

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

19824 ELECTRICAL RESISTIVITY AT LOW TEMPERATURES. J.S.Dugdale.
Science (USA), Vol. 134, 77-86 (July 14, 1961).

A non-mathematical review of the band theory of metals, particular attention being given to the resistivity at low temperatures. It is shown how measurements of the pressure coefficient of resistivity can give information complementary to that obtained from the temperature coefficient. Measurements on the monovalent metals are summarized and it is shown how information relating to the Fermi surface may be derived. In particular the observed pressure coefficient in lithium, caesium, and the noble metals can only be explained by a distortion of the Fermi surface. P.A.Walker

19825 THE SHIELDING OF A FIXED CHARGE IN A METAL. S.Shinohara.
J. Phys. Soc. Japan, Vol. 16, No. 10, 1963-9 (Oct., 1961).

The shielding of a fixed charge of an impurity atom in a metal was calculated self-consistently by means of first order perturbation theory without use of Poisson's equation. The displaced charge density of conduction electrons is finite at the centre of the fixed charge, and the dependence of the exchange potential upon the wave vector results in a uniformly displaced charge density in the crystal. The theory was extended to the case of the degenerate electron gas including two static charges.

19826 ELECTRICAL PROPERTIES OF ALLOYS OF THE SYSTEM Bi—Sb IN THIN FILMS. K.A.Ramazanov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2259-63 (Aug., 1961). In Russian.

It was shown experimentally that the specific resistances of Bi, Sb and their alloys in thin films, whose thickness was about 5×10^{-6} cm, are about 1.5 times greater than for massive specimens of the same composition. At thicknesses of the order 0.15×10^{-6} cm, the specific resistances are all "anomalously" high. Both for thin films and massive specimens a peak value of resistivity occurs when the alloy contains 25 to 30 at.% Bi. The temperature coefficients of the specific resistances of Bi, Sb, and all their alloys in thin films are less than in massive specimens. With increasing thickness, the temperature coefficient decreases and becomes negative. [English translation in: Soviet Physics—Solid State (USA)]. N.Davy

19827 THE ELECTRICAL RESISTIVITY OF ALLOYS OF THE TYPE Cu_3Au AS A FUNCTION OF ORDERING.
M.T.Béal.
J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 156-61 (Feb., 1961). In French.

The theory is given for temperatures below the transition temperature. The effect above that temperature was computed previously (Abstr. 17600 of 1961). The same approximations are used as in a previous study of β-CuZn and it is concluded here also that there is a slight influence of short-range order, in addition to that of long-range order. There is a sudden drop of resistivity at the critical point, due to the transition of first order. The same results can be observed on experimental curves.

19828 THE HIGH TEMPERATURE ELECTRICAL RESISTANCE OF IRON—ALUMINIUM ALLOYS.
R.Feder, P.H.Thornton and R.W.Cahn.
Phil. Mag. (GB), Vol. 6, 1093-1101 (Sept., 1961).

Electrical resistance, at temperatures from −196 to 700°C, was used as an indicator of crystallographic order to test the reality of certain anomalies in the long-range order in solid solutions near the composition Fe_3Al, which had previously been detected by X-ray diffraction. Resistance anomalies were found in three of the five alloys tested, containing 22.9, 23.5 and 24.8 at.% aluminium, but not in the alloys containing 22.2 and 25.5 at.% aluminium. Their significance is briefly discussed.

19829 THE ELECTRICAL RESISTIVITY OF Mn_3ZnC BETWEEN 4.2° AND 630°K.
M.L.Swanson and S.A.Friedberg.
Canad. J. Phys., Vol. 39, No. 10, 1429-32 (Oct., 1961).

The alloy had approximately the composition Mn_3ZnC. From a high residual value the resistivity increased with temperature in a complicated way up to 550°K, becoming temperature independent above that point. Two anomalous regions were evident corresponding to the magnetic transitions occurring in this substance at ~240°K and ~450°K. The general features of the results are interpreted on the basis of a spin-disorder scattering picture.

19830 DEVIATIONS FROM MATTHIESSEN'S RULE FOR PLATINUM. P.G.Klemens and G.C.Lowenthal.
Austral. J. Phys., Vol. 14, No. 3, 352-8 (Sept., 1961).

An analysis of the resistivity versus temperature relationship down to liquid helium temperatures of 17 platinum resistors as determined in various laboratories shows that deviations from Matthiessen's rule can be classed roughly into three groups. One of them follows the pattern predicted by the theory of Sondheimer and Wilson (Abstr. 2901 of 1947). The other two cannot be fully explained in this way, and may be due to the sensitivity of the electronic band structure of transition metals to small concentrations of impurities. The behaviour of a resistor thus depends on the nature as well as the total amount of impurities and imperfections. In low temperature platinum resistance thermometry the resistors should be selected with regard to the type of residual impurity as well as total impurity content.

19831 PRESSURE AND TEMPERATURE COEFFICIENTS OF THE ELECTRICAL RESISTANCE OF SOME RHENIUM ALLOYS. E.E.Pippig.
Ann. Phys. (Germany), Vol. 8, No. 5-6, 318-21 (1961). In German.

Measured in sintered alloys of rhenium with copper, silver or gold as a function of rhenium content. For rhenium concentrations up to 30 at.% the coefficients varied only slightly from the values for pure copper, silver or gold, respectively. J.A.Bornmann

19832 AN EXPERIMENTAL DETERMINATION OF THE ELECTRICAL RESISTIVITY OF STACKING FAULTS AND LATTICE VACANCIES IN GOLD. R.M.J.Cotterill.
Phil. Mag. (GB), Vol. 6, 1351-62 (Nov., 1961).

The change in the electrical resistivity of gold foils due to the introduction of (a) stacking faults, and (b) lattice vacancies, is correlated with concentration counts obtained by transmission electron microscopy. The resistivity of stacking faults is found to be $\rho_{SF} = [1.8 \pm 0.3] \times 10^{-13}\beta\ \Omega\ \mathrm{cm}^2$ for a stacking-fault density equal to $\beta\ \mathrm{cm}^{-1}$. A lower limit for the resistivity of vacancies is $\rho_V = [2.4 \pm 0.4] \times 10^{-6}\ \Omega$ cm/at.% of vacancies.

19833 GALVANOMAGNETIC EFFECTS AND THE BAND STRUCTURE OF ANTIMONY.

S.J.Freedman and H.J.Juretschke.

Phys. Rev. (USA), Vol. 124, No. 5, 1379-86 (Dec. 1, 1961).

The energy band structure of antimony is deduced from room temperature galvanomagnetic measurements and their interpretation in terms of a theoretical model. A systematic series of experiments is performed on oriented single crystals to measure all the 12 components of the isothermal resistivity tensor through second order in the magnetic field. The calculated galvanomagnetic effects assuming simple, independent three-valleyed bands for both the valence and conduction bands and isotropic relaxation times for both holes and electrons, are shown to fit the data by only one set of values for the 9 adjustable parameters in the theory. These parameters are: a set of three principal mobilities μ_i and ν_i, for electrons and holes, respectively; angles of tilt ψ_1 and ψ_2 of one of the principal axes of the electron and hole energy ellipsoids out of the base plane; and the carrier density N, the same for both carriers. The best fit is determined by exploring systematically a large number of possible solutions with the aid of an IBM 650 computer. If the "1" directions refer to binary symmetry axes and the "3" directions to those making angles ψ with the trigonal symmetry axis, the parameters have the values $\mu_1 = 0.15_4 \times 10^3$, $\mu_2 = 4.0_5 \times 10^3$, $\mu_3 = 1.1_8 \times 10^3$, $\nu_1 = 3.5_4 \times 10^3$, $\nu_2 = 3.3_0 \times 10^3$, $\nu_3 = 0.13_8 \times 10^3$ (all in $\mathrm{cm}^2\ \mathrm{V}^{-1}\ \mathrm{sec}^{-1}$); $\psi_1 = 30._7{}^0$, $\psi_2 = 63._2{}^0$; $N = 3.7_4 \times 10^{19}$ carriers/cm^3 = $1.0_5 \times 10^{-3}$ carriers/atom. The results agree well with Shoenberg's de Haas—van Alphen data if the carriers responsible for the observed susceptibility oscillations are holes.

19834 HIGHER ORDER OPEN ORBITS AND THE INTERPRETATION OF MAGNETORESISTANCE AND HALL EFFECT DATA FOR COPPER.

J.R.Klauder and J.E.Kunzler.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 125-33; Disc., 141-4.

Extensive magnetoresistance and preliminary Hall effect measurements were made for many orientations in several samples of high-purity ($R_{273^0\mathrm{K}}/R_{4.2^0\mathrm{K}}$ as large as 8000) single crystals of copper. Both transverse and longitudinal-rotational measurements were made at 18 k gauss and 4.2°K showing major regions of magnetoresistance saturation and H^2 dependence: saturation with $\Delta R/R$ as small as 0.3 and an H^2 dependence with $\Delta R/R$ as large as 2500. The major features of the anisotropic magnetoresistance behaviour are satisfactorily explained by a Fermi surface which intersects the Brillouin zone boundary only on the $\langle 111 \rangle$ faces, as proposed by Pippard and supported by others. This Fermi surface topology (" $\langle 111 \rangle$ -topology") is quite different from the one derived by Alekseevskii and Gaidukov (Abstr. 13335 of 1959) from their magnetoresistance observations, and supported by Lifshits and Peschanskii (Abstr. 2358 of 1959). Besides the major features, the authors observed additional sets of magnetic field orientations where $\Delta R/R$ does not saturate but is reduced by a factor of 10 to 100 relative to the much more prominent H^2 data. This "fine structure", which appears in the data as suppressed magnetoresistance "peaks", is explained by the presence of higher index directions along which open orbits are supported — always by the "$\langle 111 \rangle$ -topology". Such orbits involve a repeated use of a certain subset of $\langle 111 \rangle$ "arms" or "necks" to carry the higher-order open orbits. Even their existence alone is significant in determining the shape of the Fermi surface. The measured high-field Hall constant for several orientations was compared with numerical predictions derived from the Pippard Fermi surface shape. The observed and predicted values agree reasonably well along the $\langle 100 \rangle$ and $\langle 110 \rangle$ directions, and the difference between the number of "electrons" and "holes" is about 0.6 "electrons"/atom. However, better agreement is obtained if the diameter of the "necks" of the Pippard Fermi surface is increased.

19835 THE OBSERVATION OF FOUR TYPES OF HALL CONSTANT ANISOTROPY IN COPPER AND THEIR ROLE IN THE DETERMINATION OF THE FERMI SURFACE.

J.E.Kunzler and J.R.Klauder.

Phil. Mag. (GB), Vol. 6, 1045-51 (Aug., 1961).

The appropriate four of the five possible Hall constant anisotropies are demonstrated in very high purity single-crystal copper, and the results fit the model proposed by Pippard (Abstr. 2651 of 1958). C.A.Hogart

19836 OBSERVATIONS OF OSCILLATORY MAGNETORESISTANCE IN InAs AT MICROWAVE FREQUENCIES

G.Bemski and B.Szymanski.

J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 335-6 (Jan., 1961).

Transverse, oscillatory, magnetoresistance was observed in InAs at liquid helium and hydrogen temperatures using an electron spin resonance spectrometer operating at 24000 Mc/s during a search for plasma resonance absorption in InAs. The results are i good agreement with those obtained previously using d.c. techniques and the method has the advantage of high sensitivity on small, electrodeless samples. No evidence was found of spin splitting of the Landau levels. B.R.Holeman

19837 OSCILLATORY GALVANOMAGNETIC EFFECT IN METALLIC SODIUM.

R.Bowers, C.Legendy and F.Rose

Phys. Rev. Letters (USA), Vol. 7, No. 9, 339-41 (Nov. 1, 1961).

A pickup coil around a rod of pure sodium at 4°K (resistance ratio ~ 7500) showed a damped oscillatory e.m.f. when a small longitudinal field h (~ 100 G) was switched off in the presence of a large steady transverse field H. The frequency was proportional to H, and was 32 c/s for H = 10 kG. Less pure specimens gave more heavily damped oscillations of the same frequency. Using an a.c. field for h gave a resonant peak of induced e.m.f. as the frequency was varied. An approximate theory is given for an infinite medium which agrees qualitatively with the observations. R.G.Chambers

19838 IONIC CONDUCTIVITY OF THALLIUM CHLORIDE.

R.J.Friauf.

J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 203-6 (Feb., 1961).

The conductivity of single crystals of TlCl was measured with an a.c. impedance bridge. The results can be represented by the empirical formula $\sigma = \sigma_0 \exp(-W/kT)$, with W = 0.82 eV, $\sigma_0 = 5.3 \times 10^3\ (\text{ohm-cm})^{-1}$ for 370°-420°C, and W = 0.72 eV, $\sigma_0 = 8.9 \times 10^2\ (\text{ohm-cm})^{-1}$ for 160°-370°C. The result is compared with earlier work, and several reasons are advanced for considering the conductivity to be predominantly ionic. Self-diffusion coefficient for thallium obtained by use of radioactive tracers are much smaller than might be expected from the conductivity on the basis of the Einstein relation. Several tentative explanations for this apparent discrepancy are proposed, and further work is discussed.

19839 ELECTRICAL CONDUCTIVITY IN OXIDES OF MANGANESE AND RELATED COMPOUNDS.

V.G.Bhide and R.H.Dani.

Physica (Netherlands), Vol. 27, No. 9, 821-6 (Sept., 1961).

The electrical conductivity of various oxides of manganese is discussed in the light of a super-exchange mechanism. MnO, which is antiferromagnetic with five electrons in the 3d-shell, is a bad conductor because electrons cannot move down the chain of ions (Mn^{2+}) coupled antiferromagnetically without violating Pauli's exclusion principle. On the other hand MnO_2 is a good conductor with positive temperature coefficient of conductivity. Since MnO_2 has three electrons in the 3d-shell, the migration of electrons down the chain of antiferromagnetically coupled ions (Mn^{4+}) is possible. This process is shown to involve activation energy. The poor conductivity in Mn_3O_4 is explained on the basis of its structure which may be described as $Mn^{+2}(Mn^{+2}Mn^{+4})O_4$.

SURFACE RECOMBINATION AND DIFFUSION PROCESSES IN ELECTRON BOMBARDMENT INDUCED CONDUCTIVITY.
See Abstr. 20028

THE ELECTRICAL CONDUCTIVITY OF MnHg.
See Abstr. 20166

ELECTRICAL CONDUCTIVITY OF COMPLEX OXIDES $AB_{0.5}B'_{0.5}O_3$ OF PEROVSKITE TYPE. See Abstr. 20548

Semiconductors

19840 FLUCTUATIONS IN SOLIDS.

J.J.Brophy.

Phys. Today (USA), Vol. 14, No. 9, 44, 46-7 (Sept., 1961).

Report of the fifth annual symposium held at the Armour esearch Foundation on May 19, 1961. A large part of the meeting as devoted to the use of noise techniques in studying electronic ansitions in semiconductors.

19841 APPLICATION OF IRREVERSIBLE THERMODYNAMICS IN THE THEORY OF RECOMBINATION IN SEMICONDUCTORS.

G.Pataki.

cta phys. Hungar., Vol. 13, No. 1, 119-21 (1961).

A discussion of lifetimes in semiconductors is given from the oint of view of irreversible thermodynamics. The theory applies the simplest cases of recombination via defects.

P.T.Landsberg

19842 THE PROPERTIES OF SEMICONDUCTORS WITH EXTREMAL LOOPS. IV. ANGULAR DEPENDENCE OF OMBINED RESONANCE IN STRONG MAGNETIC FIELDS.

.I.Rashba and V.I.Sheka.

iz. tverdogo Tela (USSR), Vol. 3, No. 8, 2369-76 (Aug., 1961). n Russian.

For Pt III see Abstr. 14403 of 1961. The construction of a heory of combined resonance in semiconductors in strong agnetic fields, and the investigation of the angular dependence of he resonant intensity. The measurement of the intensity allows he determination of spin—orbit interaction in semiconductors with small deep extremal loops. [English translation in: Soviet Physics—Solid State (USA)].

G.E.Murphy

19843 GENERALIZATION OF THE CRITERION FOR BREAKDOWN OF SEMICONDUCTORS IN A CONSTANT ELECTRIC FIELD.

V.A.Chuenkov and Chén'-Ké-Min Ch'en-K'o-Ming].

Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2794-2803 (Sept., 1961). in Russian.

Under real conditions the division of breakdown into electric and thermal phenomena is not possible. General conditions are derived from which electric and thermal breakdown can be derived as special cases, the former occurring at low temperatures and the latter at high, between which there is a temperature at which the critical field reaches a maximum. Numerical values are calculated for NaCl and intrinsic germanium, experimental agreement for the former being satisfactory. [English translation in: Soviet Physics—Solid State (USA)].

R.Berman

19844 COMPOSITION STABILITY LIMITS OF BINARY SEMICONDUCTOR COMPOUNDS.

R.F.Brebrick.

J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 116-28 (Feb., 1961).

The composition stability limits of an essentially-ordered, non-degenerate, semiconductor crystal, MN, showing small deviations from stoichiometry, are investigated under the conditions (1) that clustering of atomic point-defects is unimportant, (2) the predominant atomic point-defects are M-vacancies and N-vacancies, (3) each M-vacancy is associated with one acceptor level and each N-vacancy with one donor level, and (4) the coexisting phase is one or the other of the pure elements M or N. Characterizing a limit of stability by the corresponding value of the net relative electron concentration, $(n - p)/2n_i$, it is found that the magnitude of the stability range is larger the more negative the standard free energy of formation of the compound and the larger the intrinsic disorder ratio. The latter is the square root of the Schottky constant for ionized vacancies divided by the intrinsic carrier concentration. The parameters determining the position of the stability range are also given. The effects of singly ionized foreign donor and acceptor impurities on the limits of stability are considered for the same crystal model under the restriction that the foreign impurity does not significantly alter the Gibbs free energy per gram-atom of the coexisting phase. The behaviour of the net relative electron concentration as a function of the concentration of ionized foreign impurities depends on the value of the former concentration in the pure compound and on the intrinsic disorder ratio. There is an asymmetry in the effects of donors and acceptors that can be large. Donor impurities are more effective in increasing the net relative electron concentration at a positive limit of stability ($n > p$) than acceptor impurities are in decreasing it. The converse holds at a negative limit of stability.

19845 DONOR STATES AND DEFORMATION AROUND IMPURITY ATOMS IN SEMICONDUCTORS.

S.Shinohara.

Nuovo Cimento (Italy), Vol. 22, No. 1, 18-30 (Oct. 1, 1961).

Assuming that impurity ions produce only point lattice defects, the change of the ionization energy of the donor state was estimated semiquantitatively. The value of 0.117 eV was obtained, putting the displacement of the nearest neighbour ion equal to 0.1 of the atom distance. The influence of the self-deformation potential of the trapped electron is negligible.

19846 HALL EFFECT IN IMPURITY CONDUCTION.

T.Holstein.

Phys. Rev. (USA), Vol. 124, No. 5, 1329-47 (Dec. 1, 1961).

The existence of a nonvanishing Hall effect in the "impurity conduction" regime of a semiconductor is demonstrated. In this regime (prevalent at low temperatures and at low impurity concentrations) the dominant electron transport mechanism is the phonon-induced hopping of charge carriers from occupied to unoccupied majority sites. The basic element of the theory is the existence of a (magnetic) field-dependent contribution to the jump probability between two sites. This contribution is computed and is shown to arise from the interference between the amplitude for a direct transition between the initial and final sites and the amplitude for an indirect, second-order transition, involving intermediate occupancy of a third site. The theory is applied to the case of an a.c. applied electric field. For values of the physical parameters representative of those occurring, for example, in the a.c. measurements of Pollak and Geballe (Abstr. 10046 of 1961), the maximum Hall angle, though small ($\sim 10^{-6}$), is found to exceed the "normal" value $[(H/c)\mu_{drift}]$ by a factor $\sim 10^2$.

19847 COLLECTIVE BEHAVIOR IN SOLID-STATE PLASMAS.

D.Pines and J.R.Schrieffer.

Phys. Rev. (USA), Vol. 124, No. 5, 1387-1400 (Dec. 1, 1961).

The conditions for the existence of plasma wave instabilities in the plasma formed by the electrons and holes in semiconductors are discussed. The dispersion relations for both the high-frequency optical mode in which electrons and holes move out of phase, and the low-frequency acoustic mode in which electrons and holes move in phase are calculated. Growing acoustic waves are shown to occur for a sufficiently large relative drift velocity of the electrons and holes, and the boundary between growing and damped waves is determined for various electron—hole temperature ratios. Growth rates are calculated for several cases of interest; when the influence of impurity and phonon scattering on the electron—hole behaviour is taken into account is is concluded that InSb is perhaps the most promising semiconductor in which to observe such instabilities. An investigation of the hole and electron temperatures and the relative electron—hole drift velocity as a function of field strength is carried out for InSb. It is shown that moderate field strengths (~ 100 V/cm) suffice to produce electron—hole drifts of the required order of magnitude for the observation of plasma wave instability; however, the scattering mechanisms present are sufficiently effective that it appears marginal whether the other condition (long hole relaxation times) necessary for the observation of the plasma wave instability is achievable in practice. In an appendix the conditions for the occurrence of similar plasma wave instabilities in semimetals are analysed briefly.

19848 USE OF INDIRECT TRANSITIONS IN SEMICONDUCTORS FOR THE DETERMINATION OF STATES WITH NEGATIVE ABSORPTION COEFFICIENTS.

N.G.Basov, O.N.Krokhin and Yu.M.Popov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1203-9 (April, 1961). In Russian.

The conditions for the formation of negative temperature states in semiconductors are obtained for indirect transitions of non-equilibrium carriers in the following two cases: (a) indirect recombination of free carriers and (b) indirect recombination from exciton states. Possible mechanisms of absorption of radiation are considered and the conditions for appearance of a negative absorption coefficient derived by taking these processes into account. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 845-9 (Oct., 1961)].

ANALYSIS OF SPECTRAL YIELD AND ACCELERATING FIELD CHARACTERISTICS OF THE PHOTOELECTRIC EMISSION FROM SEMICONDUCTORS. See Abstr. 18922

THE FARADAY EFFECT IN MANY-VALLEY SEMICONDUCTORS. See Abstr. 19959

OPTICAL DOUBLE REFRACTION CAUSED BY FREE CARRIERS IN SEMICONDUCTORS. See Abstr. 19952

MASER ACTION AT IMPURITY CENTRES IN SEMICONDUCTORS. See Abstr. 20246

CATHODIC PROCESSES ON SEMICONDUCTOR ELECTRODES. See Abstr. 20746

Semiconducting Materials

19849 PHOTOCONDUCTIVITY AND QUANTUM YIELD IN GERMANIUM UNDER THE ACTION OF X-RAYS.

M.G.Kamoldinov and E.M.Reikhrudel'.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2362-8 (Aug., 1961).
In Russian.

The effect of X-rays on the electrical conductivity (concentrations, mobility and life period of the carriers) was investigated by the method of simultaneous measurement of the conductivity and the Hall effect and their dependence on the absorbed dose of radiation. The energy of formation of an electron—hole pair and the quantum yield were determined in the wavelength interval 0.248 A to 0.062 A. The photoconductivity grows rapidly when the power of the X-ray dose is increased. [English translation in: Soviet Physics—Solid State (USA)]. N.Davy

19850 AN INVESTIGATION OF THE DEPENDENCE OF HALL COEFFICIENT ON MAGNETIC FIELD AND TEMPERATURE IN P-TYPE GERMANIUM.

O.A.Golikova and L.S.Stil'bans.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3115-22 (Oct., 1961).
In Russian.

Using p-type Ge, with carrier concentrations from 10^{13}-10^{16} cm^{-3} the dependence of Hall coefficient on magnetic field was measured for fields of 50-3800 oersted at temperatures of 77°-290°K. A qualitative explanation of the measurements is given in terms of the scattering of carriers by ionized impurity atoms. Experimental and theoretical results are compared. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Barber

19851 EFFECT OF IMPURITY-CORE ON CARRIER MOBILITY IN HEAVILY DOPED GERMANIUM. P.Csavinszky.

J. Phys. Soc. Japan, Vol. 16, No. 10, 1865-9 (Oct., 1961).

The effect of the impurity core on the mobility of charge carriers in heavily doped Ge is investigated by analysing the role the core plays in the process of ionized impurity scattering. It is concluded, in agreement with experiment, that at the same doping level the electron mobility in an Sb-doped Ge crystal should be larger than in an As-doped Ge crystal. The dependence of the mobility ratio on the electron concentration is also investigated and found to be due to changes in the screening of the impurity ions.

19852 HALL EFFECT IN N- AND P-TYPE GERMANIUM AT 24 Gc. N.Watanabe.

J. Phys. Soc. Japan, Vol. 16, No. 10, 1979-88 (Oct., 1961).

A method of measuring Hall mobility at microwave frequencies using a double mode cavity is presented. Hall mobility measured by this method corresponds to $\mu_H = (1/B) \times |\sigma_1|/\mathrm{Re}(\sigma_0)$, where σ_0 and σ_1 are diagonal and off-diagonal components of the conductivity matrix, and it is expected to be frequency independent if a constant relaxation time is assumed. Frequency dependence is expected when the energy dependent relaxation time is assumed. For n-type germanium, the Hall mobility measured by this method at 24 Gc/s is in excellent agreement with that predicted from the theory using a d.c. value and assuming acoustical mode scattering, between room temperature and 100°K. For p-type germanium, the same consideration explains the essential part of the difference between experimental values at 24 Gc/s and d.c., though there remain some discrepancies.

19853 ELECTRON—HOLE SCATTERING AND MINORITY CARRIER MOBILITY IN GERMANIUM.

T.P.McLean and E.G.S.Paige.
J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 139-49 (Feb., 1961).

In a previous publication (Abstr. 17664 of 1961) the authors presented a theory of the effects of carrier—carrier scattering on mobility in semiconductors. In this paper the specific application of the theory to germanium is discussed in the temperature and impurity concentration ranges where measurements of the minority carrier mobility have recently been performed. This is a necessa preliminary to the main part of the paper which is a comparison between the theoretically predicted and experimentally observed minority carrier mobility in the region where, previously, discrepancies of the order of a factor of two existed. By the incorporation of electron—hole scattering, theory and experiment are brought into agreement (to within 10 to 20%) for a large range of impurity concentrations, demonstrating the importance of electron—hole scattering on the minority carrier mobility.

19854 KINETICS OF DONOR REACTIONS IN OXYGEN-DOPED GERMANIUM. C.S.Fuller.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 18-28 (April, 1961).

The kinetics of the reactions leading to the formation of donors in oxygen-doped Ge were investigated by means of resistivi and Hall effect measurements. Reaction rates were measured for oxygen concentrations ranging from 0.9 to 12.0 × 10^{17} cm^{-3} oxygen over the temperature range, 300-550°C. The apparent order of reaction is shown to increase with both temperature and oxygen concentration and to approach a limiting value of four. Although the reactions are complex in the kinetic sense, and consist of serie as well as parallel reactions, both the forward and reverse reactio are shown to follow approximate first order rates over limited temperature ranges. The reaction of oxygen in the presence of copper is shown to result in the production of a neutral or paired conformation of the Cu and O atoms. The activation energy for donor generation in Cu-doped Ge is 47 kcal (2.0 ev) in excellent agreement with the activation energy for oxygen diffusion.

19855 LOW-FIELD BREAKDOWN IN N-TYPE GERMANIUM. G.Ascarelli.

Nuovo Cimento (Italy), Vol. 22, No. 2, 251-65 (Oct. 16, 1961).

Measurements of the time necessary to produce low field break down in n-type germanium were made as a function of the applied electric field; this time interval is proportional to E^{-2}. The experimental results presented, as well as the results obtained from d.c. measurements, can be explained (on the basis of the avalanche multiplication model of breakdown) it if is assumed that the distribu tion function of the electrons whose energy is smaller than the ionization energy of the impurities is given by $f(x) \propto (1 + px)\exp[-x]$ (where p is proportional to $(\mu_0 E)^2$ with μ_0 equal to the observed low field mobility, $x = \epsilon/kT$, where ϵ is the electron energy) and that th cross-section for impact ionization is constant for $\epsilon > \epsilon_0$ and equal to zero for $\epsilon < \epsilon_0$.

19856 RECOMBINATION OF ELECTRONS AND DONORS IN N-TYPE GERMANIUM. G.Ascarelli and S.Rodriguez.

Phys. Rev. (USA), Vol. 124, No. 5, 1321-8 (Dec. 1, 1961).

A calculation is given of the recombination cross-section of an electron having a spherical effective mass and a donor impurity whose bound states can be described by a hydrogenic model. The recombination takes place with an initial capture of the electron in an excited state of the donor centre followed by successive transitions to lower lying states. Each of these processes takes place wi emission of a phonon. The calculated cross-section agrees with the experimental one within a factor of the order of unity. The agreement between the temperature dependence of the calculated and the experimental recombination cross-sections is good. Also obtained is a small but significant dependence of the recombination cross-section on the binding energy of the ground state of the donor.

19857 INFLUENCE OF THE DISLOCATION DENSITY ON GERMANIUM P—N JUNCTIONS.

A.Bürger and S.Šebek.
Slaboproudy Obzor (Czechoslovakia), Vol. 22, No. 7, 407-11 (1961).
In Czech.

The influence of grain boundary dislocations (resulting in polygonized material) and the effect of randomly-distributed dislocations, on the reverse characteristics of germanium p—n junction were investigated experimentally. The first problem was studied by using a large number of wafers made from three large crystals, the dislocations being revealed by etching. The solution of the second problem required the examination of several tens of crystal having various densities of randomly-distributed dislocations. The experiments showed that those areas of Ge crystals which display polygonization and a large number of grain boundaries are unsuitable for junction diodes, since their reverse breakdown is very low. The randomly-distributed dislocations do not affect adversely the reverse breakdown, provided their density is below 2 × 10^4 cm^{-2} (for alloyed junctions). R.S.Sidorowicz

19858 THE ANISOTROPIC SCATTERING OF ELECTRONS BY IONIZED IMPURITIES.

G.Samoilovich, I.Ya.Korenblit and I.V.Dakhovskii.
okl. Akad. Nauk SSSR, Vol. 139, No. 2, 355-8 (July 11, 1961).
Russian.

For abstract, see Abstr. 17703 of 1961. [English translation in: viet Physics—Doklady (USA), Vol. 6, No. 7, 606-8 (Jan., 1961)].

19859 THE CREATION OF CURRENT OSCILLATIONS IN SILICON AT HIGH PULSE VOLTAGES.

S.Kosman and B.S.Muravskii.
z. tverdogo Tela (USSR), Vol. 3, No. 8, 2504-6 (Aug., 1961).
Russian.

Experiments were made on many specimens with resistivity to 25 ohm cm for voltages from 0 to 2000 V. Oscillograms show e current for different pulse voltages. The frequency of the scillations is generally 5×10^4 c/s and the amplitude 7-8 mA for pulse current of 30-35 mA. [English translation in: Soviet hysics—Solid State (USA)]. R.Berman

19860 SURFACE PHOTOVOLTAIC EFFECT IN SILICON AND ITS APPLICATION TO THE MEASUREMENT OF THE IFETIME OF MINORITY CARRIERS.

A.Quilliet and P.Gosar.
Phys. Radium (France), Vol. 21, No. 7, 575-8 (July, 1960).
French.

Measurements were made, on five thin single crystals of silicon, n the variation of the surface photovoltaic effect and the absorption coefficient with respect to wavelength. From these measurements was possible to obtain the lifetime of minority carriers.

19861 THE EFFECT OF HEAT TREATMENT ON THE MINORITY CARRIER LIFETIME IN SILICON.

.Asakawa.
Phys. Soc. Japan, Vol. 16, No. 10, 1923-33 (Oct., 1961).

Heat treatment centres introduced in silicon were observed by measuring the minority carrier lifetime. Immediately after quenching, a donor-like level 0.34 eV from the valence band was observed. This level was transformed into several kinds of recombination levels during the annealing process at room temperature, one of which was located at a distance larger than 0.45 ± 0.05 eV from the band edges. Other transformed centres with small activation energy could not be explained by the Shockley—Read formula. These observed properties correspond with those of iron, so that it is reasonable to consider that the thermally introduced centre is iron, and that iron acts as a recombination centre even when it is inactive to electrical conductivity. This result is consistent with previously reported properties of heat treated silicon.

19862 IONIZATION BY IMPACT OF THE IMPURITIES IN SILICON.

J.C.Sohm.
J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 181-95 (Feb., 1961).
In French.

In a semiconductor at a low enough temperature, the carriers are bound to the majority impurities. Most of these are then neutral, and the compensating impurities are ionized. The number of carriers and their mobility vary with the electric field. There is a value of the field above which ionization by impact multiplies by avalanche. This phenomenon has been observed in germanium, in indium phosphide and recently in silicon, where the author has studied it on samples of different types and compensations.

19863 THERMAL CONDUCTIVITY OF SILICON AT LOW TEMPERATURES.

J.C.Thompson and B.A.Younglove.
J. Phys. Chem. Solids (GB), Vol. 20, No. 1-2, 146-9 (June, 1961).

The thermal conductivity of several single-crystal silicon samples was measured over the range 2°-200°K. Conductivities as high as 35 watt/cm deg were observed. The concentration of the impurities (which were p-type in all but one sample) was varied from 10^{12} cm^{-3} to 10^{16} cm^{-3}. The thermal resistance for the purest samples is due to point defect (isotope) and boundary scattering. In the less pure samples an additional resistance is observed in qualitative agreement with the predicted effects of electron—phonon scattering. Comparisons are made with existing theories.

19864 THE SPECTROSCOPIC ESTIMATION OF BORON IN SILICON.

Chang Pei-Huan.
Monatsber. Deutschen Akad Wiss. Berlin (Germany), Vol. 2, No. 8, 474-9 (1960). In German.

A spectroscopic method of determining the amount of boron present as an impurity in silicon is described. When boron is present between the ratios of 1 : 10^3 and 2 : 100, the estimated accuracy is ± 8%. W.J.Orville-Thomas

INFRARED ABSORPTION SPECTRUM OF PHOTOGENERATED FREE CARRIERS IN SILICON. See Abstr. 19989

19865 PREPARATION OF ALLOYED MONOCRYSTALS AND P—N JUNCTIONS IN ALUMINUM ANTIMONIDE.

M.S.Mirgalovskaya and I.A.Strel'nikova.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 456-8 (Feb., 1961).
In Russian.

The effect of the addition of various quantities of Te, Se and S on the electrical properties of AlSb is reported. Single crystals of high ρ may be prepared by doping with 0.03% Se or 0.07% S to give p-type conduction and with 0.07% Se or 0.09% S to give n-type. A change from p- to n-type conduction can be induced by the addition of 0.05% Te, 0.07% Se or 0.09% S. The addition of 0.07-0.09% Se by weight to the melt produces p—n junctions which show rectifying properties. Optical measurements on a sample containing 0.07% Se indicated an energy gap of 1.3 eV. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 332-4 (Aug., 1961)]. G.C.Williams

19866 ORGANIC SEMICONDUCTORS: AROMATIC HYDROCARBON POSITIVE IONS IN SOLIDS.

G.E.Blomgren and J.Kommandeur.
J. chem. Phys. (USA), Vol. 35, No. 5, 1636-9 (Nov., 1961).

Mixtures of aromatic hydrocarbons with antimony pentachloride in carbon tetrachloride were studied by the methods of electron spin resonance and visible spectroscopy. The observation of a Tyndall effect and the spectroscopic properties show that the mixtures are colloidal suspensions. The visible spectra are characteristic of aromatic ions and a comparison of ion concentrations measured by visible spectroscopy and spin concentrations measured by spin resonance indicates that the aromatic ions in the solids are the only paramagnetic species present. The solids were found to exhibit high electronic conductivity.

19867 RELATIONS BETWEEN THE ELECTRONIC PROPERTIES AND THE CHEMICAL BONDING OF $Sb_xBi_{2-x}Te_{3-y}Se_y$ SYSTEM.

I.Teramoto and S.Takayanagi.
J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 124-9 (April, 1961).

The electronic properties of $Sb_xBi_{2-x}Te_{3-y}Se_y$ were investigated. The materials were prepared by melting, quenching and annealing. It is found that y_0, the value of y for which the thermoelectric power reverses from p-type to n-type, coincides with the electrical conductivity minimum, and increases with increasing x. An explanation of the results is proposed based on a model of chemical bonding in compounds of the type $A_2^{V}B_3^{VI}$. The smaller value of y_0 for x = 0 than for x = 1·0 is interpreted by taking into account the additional effect of the variation of carrier mobility with y. X-ray analysis shows that the system is a continuous solid solution with the hexagonal structure except for the region whose composition is close to Sb_2Se_3. Curves of the electrical conductivity and the thermoelectric power are discontinuous, where the admixture phases of hexagonal and orthorhombic structures are shown.

19868 THERMAL CONDUCTIVITY, THERMOELECTRIC POWER AND ELECTRICAL CONDUCTIVITY OF SEMICONDUCTING MIXED CRYSTALD OF THE FORM $(A^{I}_{x\ 2x}B^{IV}_{1-x}C^{V}_{x\ 2x})D^{VI}$.

H.Fleischmann.
Z. Naturforsch. (Germany), Vol. 16a, No. 8, 765-80 (Aug., 1961).
In German.

A large number of experimental results are reported. The main conclusions are that the thermal conductivity of mixed crystals $(Ag_{x\ 2x}Pb_{1-x}Sb(\text{or Bi})_{x\ 2x})Te$ is very low; the thermoelectric effectiveness $Z = a^2c/k_{total}$ (a = T.E.P.; c = electrical, k = thermal conductivity) can reach 0.003 degree^{-1}; the energy gap for x = 0.8 is 0.6 eV; and the effective mass ratio m_e/m_h is large. L.Pincherle

19869 ANISOTROPY OF THE GALVANOMAGNETIC PROPERTIES OF p-TYPE Bi_2Te_3.

B.A.Efimova, I.Ya.Korenblit, V.I.Novikov and A.G.Ostroumov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2746-60 (Sept., 1961).
In Russian.

Using a more general form of the relaxation time dependence, the Drabble and Wolfe (Abstr. 2202 of 1957) model of the isoenergetic surface is valid for the properties measured from 4° to 290°K. The experimental data is analysed, taking into account anisotropy of the effective mass and of the relaxation time. [English translation in: Soviet Physics—Solid State (USA)].

R.Berman

19870 GALVANOMAGNETIC EFFECTS IN BISMUTH SELENIDE Bi_2Se_3. K.Hashimoto.

J. Phys. Soc. Japan, Vol. 16, No. 10, 1970-9 (Oct., 1961).

The galvanomagnetic effects were investigated in single crystal specimens of n-type Bi_2Se_3 at 90°K. The experimental results are shown to be reasonably consistent with the six-valley model of the band structure in which the energy minima are situated on the reflection planes. The constant energy surfaces associated with the valley are ellipsoidal and the ratios of the principal effective masses are $m_2/m_1 = 0.33$ and $m_3/m_1 = 4.2$. The ellipsoids are stretched in a direction nearly parallel to the three-fold axis of the crystal. The measured values of the Hall coefficient and thermo-electric power are nearly isotropic.

19871 SOME SEMICONDUCTING PROPERTIES OF BISMUTH TRISULFIDE. L.Gildart, J.M.Kline and D.M.Mattox.

J. Phys. Chem. Solids (GB), Vol. 18, No. 4, 286-9 (March, 1961).

Single crystals, dendrites, and crystalline films of bismuth trisulphide, Bi_2S_3, were prepared and studied. From the films a thermal energy gap of 0.72 eV is found, in the range 300-400°K. From the single crystals, optical energy gaps of 1.4 eV at 77°K, and 1.2 eV at 300°K, are found; and resistivity, carrier concentration and mobility at 300°K are 0.85 ohm cm, 3×10^{17} cm^{-3} and 50 cm^2/V sec, respectively. Thermal conductivity and Seebeck coefficient are found to be 0.0206 W/cm deg C, and 550 μV/deg C, for single crystal samples in a direction parallel to the principal cleavage planes at 300°K. Preparation techniques, and the apparatus used in the thermal conductivity and Seebeck coefficient measurements, are described.

19872 MAGNETIC AND ELECTRIC PROPERTIES OF CHALCOPYRITE. T.Teranishi.

J. Phys. Soc. Japan, Vol. 16, No. 10, 1881-7 (Oct., 1961).

The torque of a natural single crystal of chalcopyrite in a uniform magnetic field was measured. At room temperature and liquid nitrogen temperature the torque of a disk parallel to the (110)-plane shows two-fold symmetry and the easy direction is $[1\bar{1}0]$. The temperature dependence of the torque was also measured. The torque vanishes at 550°C. Two principal susceptibilities parallel and perpendicular to the c-axis, $\chi_{\parallel}$ and $\chi_{\perp}$, are calculated from the torque and the powder susceptibility. The conductivity, the Hall coefficient and their temperature dependence and the thermoelectric power were also measured. Their behaviours are those of typical semiconductors. Hall mobility and thermoelectric power are rather large, although chalcopyrite contains the transition element, Fe, in its chemical formula. The crystal structure, electronic states of constituent elements and magnetic and electric properties are considered together, and it is concluded that the 3d-shell in this material is independent of the valence bond which consists of an sp^3 bond.

19873 FURTHER EXPERIMENTAL EVIDENCE ON MAJORITY CARRIER INJECTION IN CdS CRYSTALS.

I.T.Steinberger.

J. Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 354-5 (Oct., 1960).

Smith and Rose (Abstr. 4646 of 1955) and also Böer and Kümmel (for example see Abstr. 8322 of 1954) studied the d.c. characteristics of CdS single crystals and explain similar results in different ways. The former conclude that under certain conditions majority carriers are injected into the crystal and the observed effects occur only if ohmic contacts are used, while the latter attribute observed phenomena to the field release of electrons from defect states and prebreakdown avalanches. In this letter further experiments on CdS crystals are reported. The resistance of a crystal was measured in the x direction while an a.c. field (200 V r.m.s., 600 c/s) was applied in the z direction. The a.c. field was found to make no difference to the crystal conductivity. The same crystal was then examined for space charge limited currents and results similar to those of Smith and Rose obtained. It is concluded that the results of Smith and Rose cannot be explained by the internal liberation of carriers.

C.H.Gooch

19874 LOW-FIELD BREAKDOWN, NON-OHMIC CONDUCTIVITY, AND PHOTOCONDUCTIVITY OF C AT LOW TEMPERATURES. H.Shenker.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 1-7 (April, 1961).

Low temperature electrical conductivity and photoconductivit effects were investigated in highly doped CdS samples having roo temperature resistivities in the range 0.08-15 ohm cm. These samples were found to have a low-field breakdown effect at electr fields which varied from 265 V/cm to as high as 5500 V/cm depending on the sample. At fields below the breakdown field, the conductivity was concluded to be of the impurity band conduction type since the Hall mobility at 4.2°K was found to be less than 0.0 cm^2/V sec. At these fields the conductivity was found to increase markedly as the applied electric field was increased. These crystals were found to exhibit an impurity photoconductivity effect with a maximum response at 28μ and a long-wave cut-off at 32μ.

19875 SEMICONDUCTIVITY OF CHLORPROMAZINE. F.Gutmann and A.Netschey.

Nature (GB), Vol. 191, 1390-1 (Sept. 30, 1961).

Fifteen runs of heating and cooling cycles on four different samples gave a plot of log R versus 1/T which shows five parts. From 34° to 80°C (Melting Point 56·85°C) a continuous curve was obtained, corresponding to an activation energy of 2.1 eV. The discontinuity at 32°C, where the temperature coefficient of resistance reverses sign, is associated with a crystallographic change.

N.J.Dunni

ELECTRICAL PROPERTIES OF SEMICONDUCTING DIAMON

See Abstr. 19993

19876 EFFECT OF SILVER ON THE ENERGY SPECTRUM OF COPPER OXIDE.

H.V.Sandulova and Tan Pu-shan [T'ang P'u-shang].

Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 150-7 (1960). In Ukrainian.

Presents experimental proof of the formation of a new accepto level in the energy spectrum of copper oxide of 0.45-0.48 eV, arisi from the diffusion of silver in copper oxide in a 10^{-4} mm Hg vacuu at 600°-800°C. All copper oxide specimens investigated, irrespecti of the means of preparation, were established as p-type by Hall coefficient measurements. Analysis of the temperature versus conductivity curves showed that the conductivity of the copper oxide specimens in the layer field is conditioned, depending on the means of preparation, either by the layer levels 0.3-0.33 eV belonging to excessive oxygen, or by new energy levels located at a distance of 0.45-0.48 eV from the upper edge of the filled-up zone. Correlatio of the data for hole concentration (p) and acceptor admixtures (N_A) indicates that the formation of a new layer level is caused by diffusion of silver into copper oxide. Since the silver ions (Ag^+) are a donor admixture, and the new level is an acceptor level, it may be inferred that this level is not formed directly by silver ions. It is shown that the acceptor concentration in copper oxide attains 10^{20} cm^{-3}; if the same copper oxide is tempered in vacuum at 600°C the number of acceptors is reduced to 4×10^{13} cm^{-3}. Such a sharp reduction is due in this case to copper oxide oxidation by excess oxygen, known to cause formation of acceptor levels with an energy of 0.3-0.33 eV. But if silver diffusion takes place in copper oxide during tempering at 600°-800°C at a pressure of 10^{-4} mm Hg the number of acceptors is 4×10^{19} to 3×10^{19} cm^{-3}. The increase in acceptors is caused by silver diffusion, AgO (which is an acceptor admixture) being formed under these conditions. The energy of suc levels is 0.45-0.48 eV. However, if silver diffusion in copper oxide takes place at the same pressure but at 1000°C, levels with an energy of 0.45-0.48 eV do not appear and Ag_2O is formed. The conductivity of these specimens, as shown by measurements of activation energy, is due to levels with an energy of 0.3-0.33 eV, formed by excess oxygen. This means that Ag_2O does not affect the electrical properties of copper oxide. The inferred possibility of the formation of AgO or Ag_2O during silver diffusion in copper oxide depending on the pressure and temperature may be accounted for by the isomorphicity of silver with copper.

19877 SEMICONDUCTORS AND THEIR APPLICATIONS IN ELECTRICAL ENGINEERING. I. NEW SEMICONDUCT MATERIALS — SOLID SOLUTIONS OF GaAs—Ga_2Se_3.

I.A.Feltin'sh.

Trudy Inst. Énergetiki i Élektrotekh. Akad. Nauk Latv. SSR, No. 11, 5-16 (1961). In Russian.

Specimens of different compositions belonging to the system GaAs—Ga_2Se_3 were made, and examined by X-ray and micrographic

niques. It was found that the ZnS structure was maintained oughout the complete range of solid solutions, and values of sity and microhardness are given. Comprehensive electrical asurements were also made. The dependence of electrical ductivity on temperature is given for various compositions and istivities ranging from 10^{-3} to 10^{10} ohm cm are observed. The endence on composition of thermoelectric e.m.f., Hall constant bidden energy gap and the variation of number of carriers with nperature was also investigated. It is concluded that for com- itions close to GaAs the electron gas is strongly degenerate.
D.J.Barber

19878 OPTICAL DETERMINATION OF THE CONDUCTION BAND STRUCTURE OF GaSb. M.Cardona.

Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 336-8 (Jan., 1961).

The large changes with pressure and temperature of the Hall efficient of highly doped GaSb can be explained in terms of a nduction band minimum at (000) in k space, and slightly higher nima at (111). Measurements of the reflectivity, and hence of the lectric constant, of GaSb as a function of wavelength and tempera- e, yield, after several non-critical assumptions of the values of veral parameters, an estimate of the variation of the energy ference between the (000) and (111) minima at the temperatures measurement.
B.R.Holeman

ELECTRICAL PROPERTIES OF GaAs FILMS. See Abstr. 20668

19879 MEASUREMENT OF THE DIFFUSION LENGTH FOR NON-EQUILIBRIUM CURRENT CARRIERS IN InSb.

V.Galavanov, I.A.Kartuzova and D.N.Nasledov.
z. tverdogo Tela (USSR), Vol. 3, No. 10, 2973-80 (Oct., 1961).
Russian.

Valdes' light probe method is used to find the carrier fusion length L in InSb single crystals of n- and p-type with ditive concentrations of 10^{12}-10^{16} cm^{-3}. In the temperature range 0°-200°K, L is found to range between 50 and 350 μ. Lifetimes of e non-equilibrium carriers calculated from these data agree tisfactorily with the theory of radiative recombination. Deviations om this theory found for a pair of pure p-type samples with ditive concentrations of 10^{13} cm^{-3} can be explained on the theory Shockley and Read. [English translation in: Soviet Physics—lid State (USA)].
G.Wyllie

19880 ELECTRICAL AND OPTICAL PROPERTIES OF $InAs-In_2Te_3$ ALLOYS.

C.Woolley, B.R.Pamplin and J.A.Evans.
Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 147-54 (April, 1961).

The production of suitable $InAs-In_2Te_3$ alloys by annealing and directional freezing methods is considered and the relevance of e second method to the phase diagram of the system is discussed. he results of measurements of Hall effect, conductivity, thermo- lectric power and infrared absorption are given for the whole omposition range, and values of carrier density n, mobility μ and ptical energy gap E_g are obtained. It is seen that the behaviour is imilar to that of $InSb-In_2Te_3$ alloys in that the InAs rich alloys are ighly degenerate having $n \cong 5 \times 10^{19}/cm^3$ and explanations of this ehaviour in terms of solubility of tellurium in InAs or of the band tructure of InAs are discussed. The variation of μ with composi- on and hence possible scattering mechanisms and types of conduc- on occurring in the alloys are considered. Assuming certain cattering effects, attempts are made to use the values of thermo- lectric power in conjunction with the measured values of E_g to etermine the variation of intrinsic energy gap throughout the omposition range.

19881 SOME ELECTRICAL AND OPTICAL PROPERTIES OF $InAs-In_2Se_3$ AND $InSb-In_2Se_3$ ALLOYS.

.C.Woolley and P.N.Keating.
roc. Phys. Soc. (GB), Vol. 78, Pt 5(ii), 1009-16 (Nov. 15, 1961).

Polycrystalline specimens of these alloys were prepared by uitable annealing of ingots. Measurements were made of the oom temperature values of Hall effect, conductivity, thermoelectric ower and infrared absorption over the whole of the available range f solid solution, and hence values of carrier density n, mobility μ nd optical energy gap E_g determined. It is found that the behaviour s similar to that of the corresponding In_2Te_3 alloys in that the alloys ich in $A^{III}B^{V}$ are n-type and highly degenerate. The observed alues of n for the four systems concerned ($A^{III}B^{V}-A_2^{III}B_3^{VI}$) are ompared, and possible explanations of the results in terms of olubility of tellurium and selenium in the $A^{III}B^{V}$ compounds, or the band structure of the $A^{III}B^{V}$ compounds are discussed. The use of thermoelectric power data to give values of the Fermi level is considered. The use of thermoelectric power data to give values of the Fermi level is considered, and it is shown that to give consistent results in the composition range where ionized impurity scattering occurs, a scattering relation of the form $\tau \propto E^{+1/2}$ must be used. The results suggest that the $InAs-In_2Se$ system may show a change in conduction band minimum at a composition of low In_2Se_3 content.

19882 PROPERTIES OF EVAPORATED LAYERS OF InSb AND InAs. K.G.Günther and H.Freller.

Z. Naturforsch. (Germany), Vol. 16a, No. 3, 279-83 (March, 1961).
In German.

The layers were prepared by the three-temperature process, were n-type, and gave Hall constant (R) values typical of the bulk material. The highest electron mobility at room temperature was 13 000 cm^2 V^{-1} sec^{-1} for InAs and 20 000 for InSb. The mobility values increase with increasing grain size to values characteristic of bulk crystals.
C.A.Hogarth

19883 THE ELECTRICAL PROPERTIES AND STRUCTURES OF COMPLEX OXIDE SEMICONDUCTORS. II. THE SYSTEMS $MnO-CoO-NiO-O_2$ AND $MnO-CuO-NiO-O_2$.

I.T.Sheftel', A.I.Zaslavskii, E.V.Kurlina and
G.N.Tekster-Proskuryakova.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2712-25 (Sept., 1961).
In Russian.

For Pt I see Abstr. 2900 of 1960. The crystal structures throughout the composition ranges were determined for the systems $MnO-NiO-O_2$, $CuO-NiO-O_2$, $MnO-CoO-NiO-O_2$ and $MnO-CuO-NiO-O_2$. The dependence of electrical conductivity on composition is given clearly in graphical form for each system studied. The dependence of A and ΔE, in the equation $\sigma = A \exp(-\Delta E/2kT)$, on composition is given for the systems $MnO-CoO-NiO-O_2$ and $MnO-CuO-NiO-O_2$. See also following abstract. [English translation in: Soviet Physics—Solid State (USA)].
D.J.Barber

19884 THE ELECTRICAL PROPERTIES AND STRUCTURE OF COMPLEX OXIDE SEMICONDUCTORS. III. THE SYSTEM $CuO-CoO-NiO-O_2$.

I.T.Sheftel', E.V.Kurlina and G.N.Tekster-Proskuryakova.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2726-34 (Sept., 1961).
In Russian.

Semiconducting oxides of the system $CuO-CoO-NiO-O_2$ were studied and their electrical properties and crystal structures are given. The measured electrical conductivies are compared with those of "manganese" compound oxide semiconductors (see preceding abstract). Annealing in various gas atmospheres shows that compounds belonging to the $CuO-CoO-NiO-O_2$ system are not thermally stable, and this is attributed to composition changes. It is concluded that manganese plays an important role in complex oxide semiconductors. [English translation in: Soviet Physics—Solid State (USA)].
D.J.Barber

19885 VARIATION OF FIELD EFFECT MOBILITY AND HALL EFFECT MOBILITY WITH THE THICKNESS OF THE DEPOSITED FILMS OF TELLURIUM. S.K.Ghosh.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 61-5 (April, 1961).

A tentative explanation of the experimental results is offered. The low values of Hall mobility are explained to be mainly due to the scattering of the carriers at the intercrystalline boundaries.

GALVANOMAGNETIC EFFECTS IN PURE AND P-TYPE TELLURIUM. See Abstr. 20050

ELECTRON SPIN RESONANCE IN SEMICONDUCTING RUTILE. See Abstr. 20229

19886 ON THE TRANSITION TO METALLIC BEHAVIOUR IN ZINC OXIDE. J.F.Dewald.

J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 335-6 (Jan., 1961).

For zinc oxide both the flat-band potential and the slope of the conductivity versus temperature curve show a rapid, almost discontinuous, change as the donor concentration is raised through 3×10^{18} cm^{-3}. This is the behaviour to be expected as the donor concentration becomes sufficiently high for the donor wave functions to overlap, and the value of donor concentration at this point is in good agreement, after corrections for the donor energy level and

the dielectric constant, with the previously observed transition concentration in germanium at a donor density of 5×10^{16} cm^{-3}.
B.R.Holeman

19887 ORGANIC SEMICONDUCTORS. V. COMPARISON OF MEASUREMENTS ON SINGLE-CRYSTAL AND COMPRESSED MICROCRYSTALLINE MOLECULAR COMPLEXES.
P.L.Kronick and M.M.Labes.
J. chem. Phys. (USA), Vol. 35, No. 6, 2016-19 (Dec., 1961).

For previous work see Abstr. 15969 of 1960. Utilizing specialized micromanipulative techniques, measurements of conductivity, activation energy of conduction, and Seebeck coefficient were performed on charge-transfer complex single crystals. The results are compared with previous measurements on compressed microcrystalline materials.

Semiconductor Devices

19888 INVESTIGATION OF THE IMPURITY DISTRIBUTION IN THE SURFACE LAYER OF N-TYPE SILICON PHOTOELECTRIC CONVERTERS OF SOLAR ENERGY.
A.K.Zaitseva and A.Ya.Gliberman.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2377-8 (Aug., 1961).
In Russian.

A model of a photoconvertor with a p—n junction obtained by thermal diffusion of B in n-Si is described. Measurements were made on this model of impurity-concentration distribution; the optimum depth of the p—n junction for a photoconvertor was determined. Data are given also on the maximum power, resistance, open-circuit voltage and short-circuit current. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Huntley

19889 NATURE OF THE CURRENTS IN InSb P—N JUNCTIONS.
Y.Marfaing.
C.R. Acad. Sci. (France), Vol. 253, No. 5, 809-11 (July 31, 1961).
In French.

The behaviour of the direct and inverse currents in an InSb p—n junction is analysed at weak polarizations. The recombination centres in the charged region are shown to play a dominant role. They limit the direct current, and are the origin of the inverse current. J.B.Birks

19890 THE TEMPERATURE DEPENDENCE OF THE CONDUCTIVITY OF P—N JUNCTIONS IN THE BLOCKING DIRECTION. V.I.Fistul' and O.B.Orzhevskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1158-60 (April, 1961).
In Russian.

The temperature dependence is investigated on the assumption that the activation energy is lowered by the electric field. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 842-4 (Oct., 1961)]. K.G.Major

19891 GENERATION CENTRES IN DIFFUSED SILICON P—N JUNCTIONS. É.L.Nolle and G.N.Galkin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2346-9 (Aug., 1961).
In Russian.

It is shown that in diffused silicon p—n junctions, charge carriers are generated in the space charge region and collected by acceptor levels, associated with gold atoms. The acceptor levels are situated near the middle of the forbidden band, 0.35 eV from the valency band. The reverse-current characteristics of silicon p—n junctions and their variation with temperature were measured. The number of current generators and charge carriers were measured at elevated temperatures, and the results are in reasonable agreement with the numbers calculated from Morin and Maita's formula

$$n_i^2 = 1.5 \times 10^{33} T^3 e^{-(1.21/kT)}$$

[English translation in: Soviet Physics—Solid State (USA)].
D.J.Barber

19892 PHOTOCONDUCTIVITY IN A SEMICONDUCTOR DIODE, PRODUCED BY A CHANGE IN LIFETIME.
V.I.Stafeev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2513-18 (Sept., 1961).
In Russian.

A negative photoeffect is found in germanium diodes in the reverse branch of the current-voltage characteristic, and a positive in the forward branch. This is explained by a reduction in the rate of surface recombination, the volume lifetime not playing a role. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

19893 MAGNETOTUNNELING IN LEAD TELLURIDE.
R.H.Rediker and A.R.Calawa.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2189-94 (Oct., 1961

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). Rotation of a large magnetic field (~ 60 kG) in a plane perpendicular to the direction of junction current in PbTe tunnel diodes produces a periodic behaviour of this current. Diodes in which the junction current flow is along the [100], [110], or [111] crystallographic axis were investigated. The observed anisotropies are consistent with a crystal with cubic symmetry whose constant energy surfaces in k-space are ellipsoid of revolution oriented along the $\langle 111 \rangle$ crystalline axes. The magnetotunnelling results are interpreted in terms of the effective motion of each ellipsoidal valley as the magnetic field is increased valleys oriented at different angles to the electric field contributing with different weights to the tunnelling current. Quantitative comparison awaits theory. Heavier mass bands close in energy to these ellipsoids, although unimportant by themselves in tunnelling, may be necessary to explain the apparent position of the Fermi level with respect to the band edges. The excess current has the same anisotropy as the tunnelling current; however, the thermal current does not show this anisotropy and therefore must be of different origin. Hump current, which was observed in two diodes, disappeared in magnetic fields above 3 kG.

19894 ESAKI TUNNELING IN THE PRESENCE OF MAGNETIC FIELDS. R.R.Haering and E.N.Adams.
J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 8-17 (April, 1961).

The theory for Esaki tunnelling in the presence of a magnetic field is given for both transverse and longitudinal magnetic fields; it is shown that there are important qualitative differences between the two cases. Expressions are given for the normalized current I(B)/I(0) in both field orientations in the limit of strong magnetic field. It is found that oscillations of the de Haas—Van Alphen type are not to be expected.

THE PHOTOELECTRIC SENSITIVITY OF P—N JUNCTIONS IN InSb. See Abstr. 19906

SEMICONDUCTORS YIELD IMPROVED ELECTRON MULTIPLIER. See Abstr. 18923

19895 A DIFFUSION MASK FOR GERMANIUM.
E.L.Jordan.
J. Electrochem. Soc. (USA), Vol. 108, No. 5, 478-81 (May, 1961).

A technique for the production of silicon dioxide films on germanium is described. The films are produced by the thermal decomposition of alkoxysilane vapours at 600-800° C and can be removed from prescribed areas by photoresist masking and conventional etches. Films up to 2000 A thick were successfully produced and used for masking against n-type diffusants but films of 20 000 A thickness, suitable for use with p-type diffusants, caused considerable strain in the base crystal and were less successful. C.H.Gooch

Photoconductivity

19896 THE STUDY OF "NON-LINEAR" RELAXATION PROCESSES OF PHOTOCONDUCTION IN THE PRESENCE OF TRAPPING LEVELS.
L.G.Paritskii and S.M.Rȳvkin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2245-58 (Aug., 1961).
In Russian.

The decay of monopolar photoconduction for the case of arbitrary densely-populated trapping levels is considered theoretically. Under these conditions the relaxation curve has characteristic features from which the trapping level parameters can be determined. Photoconduction was investigated experimentall in single crystals of CdS, which were heavily doped with Ag, and possessed well-populated traps. The results of these experiments ee with the theory developed. A new method is suggested for estigating electron states in the forbidden band and the mechanisms hotoconduction. The technique probes localized levels using light ong wavelength, and it offers a means of determining both charge rier concentrations and relaxation curves. [English translation Soviet Physics—Solid State (USA)]. D.J.Barber

19897 PHOTOCONDUCTIVITY INDUCED IN COLOURLESS ALKALI HALIDE CRYSTALS BY STRONG ELECTRIC LDS. E.A.Konorova and L.A.Sorokina.
tverdogo Tela (USSR), Vol. 3, No. 10, 3100-4 (Oct., 1961). ussian.

It was shown experimentally that a photocurrent is generated in ourless alkali halide (NaCl, KBr, and KCl) crystals, placed in a ong (~ 5 × 10^5 V/cm) electric field. The character of the endence of the photocurrent on the applied voltage, time, temperae, and wavelength of the exciting light indicated that the effect erved is associated with electrons, liberated by the light from centres formed in the crystals on the application of a strong ctrical field, as a result of electron auto-emission from the hode. [English translation in: Soviet Physics—Solid State A)]. M.H.Sloboda

19898 THE INFLUENCE OF IMPURITIES ON THE PROPERTIES OF Sb_2S_3.
.Lyashenko and A.F.Skubenko.
tverdogo Tela (USSR), Vol. 3, No. 8, 2499-501 (Aug., 1961). Russian.

It is shown that an extra maximum in the spectral variation the photocurrent and an increase in the dark current with time due to impurities, and only disappear after 18 to 20 zone refining sses. For pure single crystals the maximum photoconductivity curs for λ = 710 mμ and the energy gap is 1.63 eV (compared with 5 eV deduced from the temperature variation of electrical ductivity). [English translation in: Soviet Physics—Solid State A)]. R.Berman

19899 VARIOUS [PHOTOELECTRIC] PROPERTIES OF SINGLE CRYSTALS OF CdS WITH AN ADMIXTURE OF GOLD.
I.Marchenko, E.A.Sal'kov, G.A.Fedorus and V.D.Fursenko.
z. tverdogo Tela (USSR), Vol. 3, No. 8, 2285-92 (Aug., 1961). Russian.

The effect of an admixture of gold on the photoelectric operties of single crystals of CdS was investigated. It was own experimentally that the admixture of gold increases their nsitivity to light, X-rays and γ-rays. This increase in sensitivity connected with the increase in the life period of the carriers of e photocurrent. It was also shown that the admixture of gold has marked effect on the position of the infrared extinction zones and es not create new levels of capture of electrons in the energy nge 0.005 to 0.500 eV. [English translation in: Soviet Physics—lid State (USA)]. N.Davy

19900 REMARKS ON PHOTOCONDUCTIVITY BY EXCITATION IN THE FUNDAMENTAL LATTICE BSORPTION EDGE OF CdS SINGLE CRYSTALS. H.Gutjahr.
onatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 5, 39-71 (1960). In German.

In order to explain the previous conclusion (Abstr. 1724 of 1960) at photoconductivity of CdS, even at the fundamental absorption dge, is due to the lattice defects, the following assumptions are ade. The mean lifetime of holes and electrons excited from the alence band are much less than the mean lifetime of the electrons roduced from a lattice defect. The lattice defects have a much rger capture cross-section for holes than for electrons. The attice defect gives photoconductivity by direct excitation or by an ndirect, but equivalent, sensitization in which an electron is first xcited from the valence band to the conduction band but the hole us formed is immediately trapped by the lattice defect.
J.A.Bornmann

19901 INVESTIGATION OF THE DECAY TIME OF THE PHOTOCURRENT IN CdS MONOCRYSTALS AT ARIOUS TEMPERATURES AND ILLUMINATIONS.
.P.Trofimenko and G.A.Fedorus.
krayin. fiz. Zh. (USSR), Vol. 5, No. 1, 12-25 (1960). In Ukrainian.

The decay time τ of the photoconductivity in CdS monocrystals fter extinction of the light was studied over a wide temperature ange and at different illuminations. The measurements were onducted under various conditions of excitation of the specimens, which permitted in a number of cases a distinction between processes connected with recombination of photoelectrons and phenomena caused by the thermal release of electrons from traps. It is shown that the photocurrent decay times measured under quasi-stationary conditions with high illumination of the samples by white light (10^{18} quanta/cm^2 sec) correspond, essentially, to the lifetimes of photoelectrons in a free state. In the case of weak illumination (10^{13}-10^{14} quanta/cm^2 sec) the measured photocurrent decay times are usually connected with the recombination of photoelectrons released from traps. A preliminary criterion is presented for determining the process with which the measured photoconductivity decay time is connected. A correlation is established between certain kinetic characteristics and the concentration and depth of electron traps. In the case of a sufficiently high concentration of traps, their depth of occurrence may be determined from the temperature dependence. It is shown that effects associated with thermal expulsion of electrons from the trap may be eliminated on measuring τ under pulse conditions.

19902 ROLE OF CONTACTS IN THE PHENOMENA OF THE PHOTOEXCITATION AND INFRARED QUENCHING OF PHOTOCONDUCTIVITY IN CdS SINGLE CRYSTALS.
Ye.A.Salkov, H.A.Fedorus and M.K.Sheinkman.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 141-9 (1960). In Ukrainian.

It was shown that the lux—ampere dependence, photocurrent kinetics, photoexcitation and infrared quenching of photoconductivity are not manifestations of contact properties, but are consequences of semiconductor processes.

19903 THE NATURE OF GAMMA-CONDUCTIVITY OF CADMIUM SULPHIDE CRYSTALS.
I.D.Konozenko, V.I.Ust'yanov and A.P.Halushka.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 276 (1960). In Ukrainian.

Discusses the mechanism of the additional electrical conductivity due to γ-irradiation.

19904 THE KINETICS OF INDUCED IMPURITY PHOTOCONDUCTIVITY IN CADMIUM TELLURIDE.
E.N.Arkad'eva, R.S.Kasȳmova and S.M.Rȳvkin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2417-26 (Aug., 1961). In Russian.

The capture cross-sections for photons of the levels responsible for induced photoconductivity in n- and p-type specimens are determined from the relaxation curves of the growth and decay of induced photoconductivity. The cross-section for n-type is an order of magnitude greater than for p-type. The level systems for the two types are deduced. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

19905 INVESTIGATION OF THE IMPURITY PHOTOCONDUCTIVITY OF GERMANIUM IRRADIATED WITH GAMMA RAYS. S.M.Rȳvkin, R.Yu.Khansevarov and I.D.Yaroshetskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3211-19 (Oct., 1961). In Russian.

The infrared spectral distribution and the relaxation time of the impurity photoconductivity were measured for samples of n-type germanium which had been irradiated with Co^{60} γ-rays. It was shown that the irradiation produced radiative defects which give photoconductivity for wavelengths up to 6 microns, and which may be explained on the basis of two independent radiative defect levels of energies $E_c - 0.2$ eV and $E_V + 0.26$ eV. The kinetics of the impurity photoconductivity associated with the $E_c - 0.2$ eV level were investigated. Quenching of the impurity photoconductivity by simultaneous irradiation with visible light was observed and related to the capture of photons at the $E_c - 0.2$ eV level. [English translation in: Soviet Physics—Solid State (USA)]. D.A.O'Connor

19906 INFLUENCE OF THE SURFACE ON THE PHOTOELECTRIC SENSITIVITY OF P—N JUNCTIONS IN InSb. Y.Marfaing.
C. R. Acad. Sci. (France), Vol. 253, No. 4, 626-8 (July 24, 1961). In French.

The photoconductivity of p—n junctions in InSb was investigated in the region of strong absorbtion. The experiments were performed with different ambient atmospheres thus altering the condition of the surface and hence the surface charge. An expression relating the surface charge and the surface recombination rate was formulated; using this result the recombination rate in the various surfaces was deduced. A.J.Fox

19907 A NEW TYPE OF PHOTOCONDUCTIVITY. M.I.Korsunskii, N.S.Pastushuk and G.D.Mokhov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2667-8 (Sept., 1961).
In Russian.

A new type of photoconduction is reported in specimens of mercuric selenide, irradiated in a vacuum in the wavelength range 0.420-0.715 μ. The photocurrent does not depend on the intensity, but increases strongly with increasing wavelength in the range 0.490-0.610 μ. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Barber

19908 CONCERNING THE NATURE OF A NEW TYPE OF PHOTOCONDUCTIVITY. M.I.Korsunskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3181-6 (Oct., 1961).
In Russian.

The new type of photoconductivity reported for mercuric selenide (see preceding abstract) is explained on the basis of radiation-induced recombination of charge carriers. A theory for this mechanism of photoconduction is presented. It is also shown that an alternative hypothesis of the resonance saturation of traps does not satisfy the experimental observations. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Barber

19909 QUENCHING EFFECTS AND NEGATIVE PHOTOCONDUCTIVITY IN AMORPHOUS SELENIUM.
J.Dresner.
J. chem. Phys. (USA), Vol. 35, No. 5, 1628-35 (Nov., 1961).

Negative photoconductivity and long wavelength quenching of photoconductivity were observed in several evaporated layers of amorphous Se, with both effects showing a maximum for light of energy between 1.9 and 2.1 eV. From the position of the Fermi level, these effects are identified with transitions from a set of sensitizing centres ranging from less than 0.58 to 0.65 eV above the valence band. Deep traps were investigated by thermally stimulated currents and by the analysis of space charge limited currents. Trapping states at 0.55 eV were detected which probably correspond to the same set of defect levels as the sensitizing centres. Several models which might account for the optical absorption, spectral response, quenching phenomena, and the exponential temperature dependence of the carrier mobilities, are discussed.

19910 TEMPERATURE AND INTENSITY DEPENDENCE OF THE PHOTOCURRENT AND LUMINESCENCE IN A REACTION-KINETICS MODEL FOR SULPHIDE PHOSPHORS.
J.Voigt.
Phys. Status solidi (Germany), Vol. 1, No. 3, 257-72 (1961).
In German.

The steady-state photoconductivity as a function of light intensity and temperature, and the steady-state luminescence as a function of light intensity, are studied on the basis of a model involving two different kinds of defect level. Optical excitation of electrons from activator levels into the conduction band is considered. Expressions for the concentration of conduction electrons and for the luminescent intensity are derived on the single assumption that the activator levels are not saturated with holes. The case of supralinearity is discussed in detail, The results are compared with earlier work.

19911 PHOTOCONDUCTIVITY IN Tl(Br, I). B.N.Mazonaschwili and M.Höhne.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 3-4, 163-6 (1960). In German.

Illumination of Tl(Br, I) at 21° K gives photoconductivity which does not decay to zero, and repeated illumination gives progressively greater photoconductivity. However, at 90° K, decay to zero occurs within minutes and the photoconductivity is reproducible with repeated illumination. The behaviour is explained in terms of shallow traps. J.A.Bornmann

19912 A MONOPOLAR NON-STATIONARY PHOTOMAGNETIC EFFECT. A.A.Grinberg and S.M.Rȳvkin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2470-4 (Aug., 1961).
In Russian.

In a semiconductor with monopolar (e.g. impurity) photoconduction, the photomagnetic effect (p.m.e.) is absent for constant conditions of illumination. It is shown that under non-stationary illumination conditions there is a net p.m.e. The magnitude of the p.m.e., and its relaxation curve, is calculated for irradiation with rectangular light pulses. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Barber

SIMPLE ELECTROMANOMETER UTILIZING THE CdS PHOT CONDUCTIVE CELL. See Abstr. 18340

ERRORS IN PHOTOELECTRIC DEVICES. See Abstr. 18580

Thermoelectric Properties

SUMMARIZED PROCEEDINGS OF A CONFERENCE ON THERMOELECTRICITY. See Abstr. 18750

19913 VARIATION OF THERMOELECTRIC POWER OF METALLIC ALLOYS OF THE β-CuZn TYPE AS A FUNCTION OF ORDERING. M.T.Beal.
J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 150-5 (Feb., 1961).
In French.

In a theoretical study the author predicts a general lowering of the thermoelectric power and anomalies at the transition point which are more or less sharply marked. These calculations can be directly transposed to a magnetic study.

PELTIER EFFECT IN Bi, Te AND Bi_2Te_3. See Abstr. 20438

19914 THERMOELECTRIC PROPERTIES OF FERROMAGNETIC METALS AND THEIR ALLOYS.
N.V.Kolomoets and M.V.Vedernikov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2735-45 (Sept., 1961).
In Russian.

The concentration and temperature dependence (between 20° and 1200° C) of the thermo-e.m.f. of Ni—Co, Ni—Mn, and Co—Fe alloys was determined. An approximate theoretical expression for the thermo-e.m.f. was derived, and a qualitative explanation of its dependence on the band structure of metals was formulated which, together with the experimental results, was used in postulating band configurations for Fe, Co, and Ni. These, in turn, were used to provide a satisfactory explanation of both magnetic and thermoelectric properties of the metals studied. [English translation in: Soviet Physics—Solid State (USA)]. M.H.Sloboda

19915 THE THERMOELECTRIC POWER OF THE GAMMA-BRASSES. S.Noguchi.
J. Phys. Soc. Japan, Vol. 16, No. 10, 1909-12 (Oct., 1961).

The thermoelectric power of the gamma-phase alloys in the copper—zinc system was measured at room temperature relative to pure copper. The thermoelectric power is found to be a smooth function of composition except in the range between 64.4 and 65.4 at.% Zn where there is a discontinuous change. Analysis band on a band-approximation suggests that such a discontinuity can be attributed to the extinction of a band of electron holes or the initiation of a band of overlap electrons. However, there is a practical difficulty in distinguishing between the two processes, since the discontinuity occurs in the same and negative direction in either case. This difficulty was overcome using extra informatic concerning the Brillouin zone of the gamma-phase, and the discontinuity was interpreted in terms of the electron overlap across the {411} plane.

THERMOELECTRIC POWER OF Fe—Al ALLOYS. See Abstr. 20592

19916 THE MECHANISM OF THE SCATTERING OF CHARGE CARRIERS IN LEAD TELLURIDE.
E.D.Devyatkova and I.A.Smirnov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2310-18 (Aug., 1961).
In Russian.

The change in thermal conductivity with temperature was measured for PbTe, and the experimental and theoretical dependences of thermoelectric e.m.f. on temperature are compared. Fro measurements of the electronic contribution to thermal conductivit and the temperature dependence of mobility, it is concluded that electrons are scattered predominately by acoustical lattice vibrations. The appendix contains an approximate calculation of the lattice thermal conductivity and total thermal conductivity for n-type PbTe, doped with lead halides. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Barbe

19917 THERMOELECTRIC BEHAVIOURS OF RUTILE.
K.Sakata.
. Phys. Soc. Japan, Vol. 16, No. 5, 1026 (May, 1961).

Gradual changes in the conductivity and thermo-e.m.f. as ctions of temperature were observed with different oxygen ssures. The activation energy increases with the partial oxygen ssure up to 3.0 eV which may correspond to the forbidden band). It is suggested that metallic conduction in highly reduced rutile es place in the narrow d-band and intronsic conduction begins to dominate at about 1150°C. I.Cooke

ielectric Properties

19918 POSITRON ANNIHILATION IN INSULATORS.
A.Bisi, A.Fasana, E.Gatti and L.Zappa.
ovo Cimento (Italy), Vol. 22, No. 2, 266-74 (Oct. 16, 1961).

The time distribution of the positron annihilation radiation in rious plastic insulators was measured with a time-to-height conrter. For each material, the abundance I_2 and the mean-life τ_2 long-lived positronium were measured together with the mean-life of positrons annihilating with shorter lifetime. The values obined for I_2, τ_2 and τ_1 were found to vary respectively between 10% d 45%, 1.2 and 2.6×10^{-9} s, 1.5 and 3.0×10^{-10} s. The bulk of the component was made up of the non-positronium decay; from the τ_1 lues the mean-life τ_f was deduced for the unbound positron annihition. τ_f was found to vary between 1.5 and 3.0×10^{-10} s. A rough tempt to correlate the measured lifetimes with the effective elecon densities suggested that polarization effects connected with icroscopic fields play a significant role.

19919 THE TEMPERATURE DEPENDENCE OF DIELECTRIC CONSTANTS. E.E.Havinga.
Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 253-5 (Feb., 1961).

It is shown that for isotropic and for cubic materials there are ree factors contributing to the temperature dependence of a diectric constant: a direct volume expansion effect and the influences volume expansion and of temperature on polarizability. A simple ethod is given to determine the values of the separate contributions om measurements. The magnitudes of the three effects are calcuted and discussed, for some alkali halides and $BaTiO_3$.

POSITRONIUM ANNIHILATION IN SOLID DIELECTRICS: FFECT OF A STATIC ELECTRIC FIELD. See Abstr. 19754

DIELECTRIC PROPERTIES OF NaCl-TYPE CRYSTALS. ee Abstr. 19691

19920 DIELECTRIC LOSSES AND ELECTRICAL CONDUCTIVITY OF FLUORITE.
.I.Nikitinskaya and T.V.Bol'shakova.
iz. tverdogo Tela (USSR), Vol. 3, No. 10, 3224-8 (Oct., 1961).
n Russian.

The conductivity and dielectric losses in the range 400-0 000 c/s were measured for pure fluorite and for about .01% Eu^{++}. σ and tan δ (at low frequencies) are much greater for he impure crystal. For the pure crystal the losses are practically ndependent of frequency, but at room temperature a $1/\omega$ law is ollowed for the impure crystal. X-irradiation of the impure crystal educes the losses (colouring by X-rays is also more rapid for mpure crystals). The increase in conductivity and losses are elated to a possible increase in dislocation density on introducing mpurity into the lattice. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

19921 DIELECTRIC α- AND β-DISPERSIONS IN POLYVINYL BUTYRAL (PVB). Y.Takahashi.
J. Phys. Soc. Japan, Vol. 16, No. 5, 1024 (May, 1961).

The dielectric loss ϵ'' in a sample of PVB, which was heat-treated at 200°C for 30 min, was measured in the temperature range -70° to 120°C and the frequency range 0.3 to 10^6 c/s. The higher temperature dispersion labelled as α and the lower temperature dispersion labelled as β were observed. The plot of log f_m versus 1/T (where f_m is the frequency at which ϵ'' is maximum) is a curve for the α-dispersion but a straight line for the β-dispersion. The dielectric activation energies for the former are 93, 66, 53, 42 and 34 kcal/mol at 80°, 92°, 102°, 110° and 120°C respectively. For the β dispersion, the energy is 12 kcal/mol and is independent of temperature. S.C.Jain

19922 THE EFFECT OF UNIPOLARITY OF ROCHELLE SALT ON ITS ELECTRICAL PROPERTIES. K.N.Karmen.
Kristallografiya (USSR), Vol. 6, No. 3, 426-31 (May-June, 1961).
In Russian.

The method for studying the unipolarity of Rochelle salt has been improved. It has been found that the prolonged action of a field causes a change in the unipolarity. The time needed to change the unipolarity considerably exceeds the time for rearranging the domain structure under the same conditions. The stability of the state achieved depends on the history of the specimen, the value and sign of the intensity of the constant electrical field. [English translation in: Soviet Physics—Crystallography (USA), Vol. 6, No. 3, 336-40 (Nov.-Dec., 1961)].

19923 INVESTIGATION OF REORIENTATION OF THE GUANIDINIUM ION IN THE FERROELECTRIC $C(NH_2)_3.Al(SO_4)_2.6H_2O$ BY THE NUCLEAR MAGNETIC RESONANCE METHOD.
A.G.Lundin, G.M.Mikhailov and S.P.Gabuda.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1282-8 (May, 1961).
In Russian.

Reorientation of the $[C(NH_2)_3]^+$ ion in guanidine aluminium sulphate hexahydrate (GASH) was detected at temperatures above 130°K by nuclear magnetic resonance. The temperature dependence of the second moment of the absorption line in a polycrystalline sample was measured between 90 and 400°K. The height of the potential barrier for reorientation of the $C(NH_2)_3$ group was estimated and some conclusions regarding the mechanism of reorientation are drawn. [English translation in: Soviet Physics—JETP (USA)].

DIELECTRIC PROPERTIES OF THE $PbTiO_3$—$SrSnO_3$ SYSTEM. See Abstr. 20575

19924 PROTON MAGNETIC RESONANCE STUDY OF FERROELECTRIC $NaH_3(SeO_3)_2$ AND $LiH_3(SeO_3)_2$.
R.Blinc and M.Pintar.
J. chem. Phys. (USA), Vol. 35, No. 3, 1140-1 (Sept., 1961).

The lithium compound which is ferroelectric up to the melting point (110°C) exhibits no linewidth transition in the temperature range -175°- 80°C. A small linewidth transition is shown by the sodium compound in the vicinity of the Curie point at -79°C, indicating a rearrangement of proton sites. Complementary studies of the hydrogen vibration spectra in the non-ferroelectric and ferroelectric phases are described. The assumption of a dynamic order—disorder phase transition of basically the same nature as in KH_2PO_4 is supported by the experimental evidence. W.Good

19925 INVESTIGATIONS ON FERROELECTRICS AND THEIR USE IN DIELECTRIC RESONANCE AMPLIFIERS.
W.Krähmer.
Jenaer Jahrbuch (Germany), 1960 II, 645-86. In German.

The first part reports extensive tests on ceramic dielectrics of the modified $BaTiO_3$ type, the specimens being 0.1 mm thick and having vacuum-deposited electrodes. The permittivity and loss tangent were measured as functions of applied a.c. field, d.c. bias fields and combinations of the two at different temperatures with respect to the Curie point, and at various frequencies. The second part reports on the use of the ceramics as dielectric amplifiers in a resonant circuit. It was found that the maximum voltage gain was only 1.4 and the amplifier lacked stability as regards both temperature and frequency of the auxiliary signal. K.W.Plessner

SOUND ABSORPTION IN ROCHELLE SALT CLOSE TO ITS LOWER CURIE POINT. See Abstr. 19704

EFFECT OF OXYGEN PRESSURE ON ELECTRICAL PROPERTIES OF RUTILE. See Abstr. 19917

ANOMALOUS VARIATIONS IN THE DIELECTRIC AND PIEZOELECTRIC PARAMATERS OF $(Ba, Pb)TiO_3$ SOLID SOLUTIONS. See Abstr. 20504

ANOMALOUS TEMPERATURE DEPENDENCE OF LATTICE CONSTANTS OF FERROELECTRIC SODIUM NITRITE. See Abstr. 20560

19926 THE NATURE OF DIELECTRIC LOSSES IN POLYCRYSTALLINE TITANATES OF MAGNESIUM AND ZINC, IRRADIATED IN A LARGE INTEGRATED BEAM OF SLOW NEUTRONS.

L.K.Vodop'yanov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2331-5 (Aug., 1961).
In Russian.

Discs of magnesium and zinc titanates were irradiated in a beam of slow neutrons, and the dielectric permeability, ϵ and the tangent of the angle of loss, tan δ were measured at acoustic and radio frequencies. The frequency dependence of ϵ'' before and after irradiation was measured and the results were compared with a theoretical curve. The temperature dependence of tan δ was also measured. A mechanism is suggested for the formation of lattice defects by γ-ray quanta released from excited nuclei. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Barber

19927 ELECTROCALORIC EFFECT IN POLYCRYSTALLINE BARIUM TITANITE.

A.I.Karchevskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3092-9 (Oct., 1961).
In Russian.

Reversible temperature changes during adiabatic polarization in electric fields up to 7.5 kV cm^{-1} were investigated from -80° to $+135^{\circ}$C. A sharp maximum was found in the electrocaloric effect at 118°C. The position of the maximum remained unchanged in fields from 1.5 to 7.5 kV cm^{-1}. The temperature dependence of the dielectric susceptibility, which had a maximum at 121°C, was found to be displaced linearly with E at $+0.4 \times 10^{-3}$ deg C $(V/cm)^{-1}$. It is shown that for second-order phase transitions the maximum of the electrocaloric effect is practically independent of E and consequently, the transition at 118°C is analogous in these properties to a second-order phase transition. The results obtained are briefly discussed and compared with the data and conclusions of other authors on various properties of barium titanite and other ferroelectrics. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Huntley

19928 A NOTE ON THE THEORY OF BARIUM TITANATE.

H.Takahasi.
J. Phys. Soc. Japan, Vol. 16, No. 9, 1685-9 (Sept., 1961).

A careful consideration of lattice vibrations in ionic ferroelectric crystals such as $BaTiO_2$ reveals that a correct physical picture of the ferroelectric transition in these crystals may better be regarded as the order—disorder transition of an orientation of dipoles. A characteristic feature is strong local order in the disordered phase. The model gives a natural interpretation of the occurrence of three successive transitions in $BaTiO_3$, and predicts dielectric dispersion of a relaxation type in the paraelectric phase.

19929 EXPERIMENTS ON THE DIELECTRIC PROPERTIES OF SOME FERROELECTRIC CERAMICS AT LOW TEMPERATURES.

E.Hegenbarth.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 1, No. 7-10, 411-15 (1959). In German.

Experiments are reported on ceramic materials whose Curie points lie in the range 12-80°K. The dielectric constants of $CdTiO_3$, $(Ba_{0.1}Sr_{0.9})TiO_3$, and $(Ba_{0.05}Sr_{0.95})TiO_3$ were measured both with and without biassing voltages. C.A.Hogarth

19930 DIELECTRIC AND X-RAY STUDIES OF $Ca_xBa_{1-x}TiO_3$ AND $Ca_xSr_{1-x}TiO_3$.

T.Mitsui and W.B.Westphal.
Phys. Rev. (USA), Vol. 124, No. 5, 1354-9 (Dec. 1, 1961).

Ceramics of $Ca_xBa_{1-x}TiO_3$ and $Ca_xSr_{1-x}TiO_3$ were prepared and their dielectric and structural properties investigated. Firing conditions were adjusted to obtain sharp X-ray back reflections. The Curie point of $Ca_xBa_{1-x}TiO_3$ increases with Ca concentration up to 136°C for $x = 0.08$, and then decreases. Both the tetragonal—orthorhombic and the orthorhombic—rhombohedral transition points of $Ca_xBa_{1-x}TiO_3$ decrease monotonically with increasing Ca concentration. $Ca_xSr_{1-x}TiO_3$ solid solutions with $0.01 \leq x \leq 0.10$ are ferroelectric at very low temperatures. $SrTiO_3$ assumes a tetragonal structure below about 80°K.

19931 NONLINEAR FERROELECTRIC SYSTEMS WITH VARIOUS CURIE TEMPERATURES.

M.M.Nekrasov and Yu.D.Kobtsev.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 1, 75-8 (1960). In Ukrainian.

It is shown that it is possible to obtain ferroelectric systems with various Curie temperatures in ternary systems on a $Ba(Ti, Sn, Zn)O_3$ base. Depending on the procedure and conditions of quenching, it is possible to obtain various properties of this sy and to influence the Curie temperature to a great extent. The bas characteristics of ternary systems on a $Ba(Ti_{0.75}, Sn_{0.1}, Zr_{0.15})O_3$ base are given in the paper.

19932 SOLUTION OF THE PROBLEM OF THERMAL SPARK-OVER IN HETEROGENEOUS DIELECTRICS SUBJECTED TO UNSYMMETRICAL BOUNDARY CONDITIONS.

S.N.Koikov and A.N.Tsikin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2553-63 (Sept., 1961).
In Russian.

A theoretical solution is obtained for the problem of thermal spark-over of a dielectric when subjected to the passage of a constant current and to unsymmetrical thermal conditions. An exponential relationship is assumed between temperature and specific resistance. Graphs based on the solution are given which enable the breakdown voltage to be estimated. [English translatio in: Soviet Physics—Solid State (USA)]. R.F.S.Hearm

19933 PREBREAKDOWN PHENOMENA IN KCl AT TEMPERATURES OF 250-350°C.

V.F.Pisarenko.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 2996-3001 (Oct., 1961).
In Russian.

Single crystals of KCl in the form of 4 mm cubes have Al electrodes evaporated on to opposite faces. A voltage source of u to 1 kV in series with ~ 1MΩ supplies current. The initial resistance of about $10^9 \Omega$ drops with time by a factor of 10^2 to 10^4. This drop is usually but not always accompanied by the growth of metal dendrites in the crystal owing to electron emission from the cathode, formation of chlorine at the anode, and precipitation of colloidal potassium in a thin layer near the anode as a result high electron concentration there. In the range 180° to 90°C, a marked increase in resistance was found on illumination. This ha not been studied in detail. [English translation in: Soviet Physic Solid State (USA)]. G.Wyl

19934 THE KINETICS OF E.M.F. FROM HIGH-VOLTAGE POLARIZATION OF DIELECTRICS.

M.L.Chetkarov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2193-6 (Aug., 1961).
In Russian.

Using macroscopic equivalent circuit concepts the author derives theoretical expressions for the e.m.f., the reverse and residual current densities, and the dependence of the polarization field on the conductivity of the dielectric under conditions of high-voltage polarization. [English translation in: Soviet Physics—Solid State (USA)]. R.Haywar

19935 THE THEORY OF PHOTOELECTRETS.

M.L.Chetkarov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2197-2201 (Aug., 1961).
In Russian.

A theory of photoelectrets is developed from the general conclusions reached in a previous paper (see preceding abstract). The theoretical dependences of the densities of photocurrent and depolarization current on the illumination of the specimen agree w with experimental results in the case of an orthorhombic sulphur crystal. The energy level of traps is 0.386 eV. The calculated curve of the residual polarization of the photoelectret as a functio of the time during which it has remained in darkness gives a good agreement with experiment provided the parameters have reasonable values. [English translation in: Soviet Physics—Solid State (USA)]. F.Lachma

19936 CRYSTAL STABILITY AND THE THEORY OF FERROELECTRICITY. II. PIEZOELECTRIC CRYSTALS.

W.Cochran.
Advances in Phys. (GB), Vol. 10, No. 40, 401-20 (Oct., 1961).

In Pt I (Abstr. 8971 of 1961) the dielectric properties of cubi crystals with atoms in special positions were discussed, with particular reference to crystals which become unstable against a transverse optic mode of vibration of long wavelength. These considerations are now extended to crystals of general symmetry and it is shown that the anomalous temperature dependence of certain dielectric, piezoelectric, and elastic constants in the paraelectric phase of ferroelectric crystals can be described and correlated in a very natural way in terms of crystal stability. A formula relating the dispersion frequency of the anomalous dielectric constant to the spontaneous polarization and the displacements of the atoms in a ferroelectric transition, previously derived for barium titanate, is generalized. The transitions in

PO_4 and in $NH_4H_2PO_4$, and the ordering of the hydrogen atoms in se crystals, are discussed qualitatively in terms of the stability ormal modes of vibration.

19937 SOME ELECTROMECHANICAL EFFECTS ON DIELECTRICS. K.C.Kao.
t. J. appl. Phys., Vol. 12, No. 11, 629-32 (Nov., 1961).

On the basis of the principle of minimum potential energy, chanical forces in electrically stressed dielectrics were derived. ese forces are appreciable in strong electric fields. A brief cussion is given of the various forces with particular reference their effects on the dielectric breakdown.

OPTICAL PROPERTIES OF SOLIDS

(Including X-ray Spectra)

19938 OPTICAL PROPERTIES OF METALS. J.A.Rayne.
rmi Surface Conference Paper, Cooperstown, New York, Aug., 1960 ee Abstr. 11180 of 1961) p. 266-78; Disc., 309-16.

The optical properties of metals and alloys can give useful ormation about their band structure. A survey of the various pes of measurement is given and the results of recent experi- ents are discussed.

19939 OPTICAL AND STRUCTURAL PROPERTIES OF THIN METAL FILMS. INFLUENCE OF SPEED OF ORMATION. R.Philip.
nn. Phys. (France), Vol. 5, No. 7-8, 805-64 (July-Aug., 1960). French.

A careful and extensive study was made of the optical properties of gold and silver films prepared under reproducable conditions. he optical properties were determined under normal incidence in r using light of varying wavelengths and particular attention was id in the case of silver to the transparent band (3100-3200 A). the case of gold, the optical properties were measured under acuum and then in air. The speed of film production was found have a very marked effect on the optical properties; for example e absorption of gold was multiplied by a factor of 25 if the speed f growth varied from 25 to 0.8 mm per minute. A discussion of the heory due to David (1939), who suggests that the films consist of lementary resonators with fundamental frequency in the infrared r red, is included and some idea of the magnitude of the crystallites obtained. T.C.Toye

19940 OPTICAL PROPERTIES OF Sb, Te, AND Ti FILMS IN THE VACUUM ULTRAVIOLET.
.P.Rustgi, W.C.Walker and G.L.Weissler.
. Opt. Soc. Amer., Vol. 51, No. 12, 1357-9 (Dec., 1961).

The reflectivity and transmissivity of Sb, Te, and Ti films were measured in the range from 1600 to 450 A in order to compare the requency at which the films change from a reflecting to a transmitting medium with the plasma frequency predicted by Bohm and Pines and also with electron energy characteristic losses in metals bserved by Marton et al. and by Powell.

19941 OPTICAL CONSTANTS OF LiF IN THE EXTREME ULTRAVIOLET. R.Kato.
. Phys. Soc. Japan, Vol. 16, No. 7, 1476 (July, 1961).

Measurements of absorption and reflection spectra of LiF single crystals reported earlier (Kato et al, Abstr. 14591 of 1961) were improved by avoiding errors due to hydrolysis of the crystal surface. The results were also corrected for reflection from the back wall in the transparent region. Corrected reflectivities agree with those calculated from the known refractive indices in the near ultraviolet. Using the phase computed from the Kramers—Kronig relation and the measured reflectivity, the dependence of the refractive index and the extinction coefficient on photon energy is calculated. The results of these calculations are used to obtain a value 0.42 ± 0.03/ion for the oscillator strength, which is in good agreement with the calculations of Dexter (Abstr. 805 of 1958) for NaCl. S.C.Jain

19942 OPTICAL STUDY OF ANILINE HYDROBROMIDE SINGLE CRYSTAL. T.Iwai.
J. Phys. Soc. Japan, Vol. 16, No. 9, 1739-45 (Sept., 1961).

A domain structure previously investigated by an X-ray study of aniline hydrobromide was directly confirmed by optical means. The domain walls were found to move easily by a shearing force. The temperature dependence of the extinction angle was obtained. The thermal transition of transparency was measured, and interpreted on the basis of the domain structure. The refractive indices were also measured. Although double refraction was found to be fairly large, any anisotropy of optical absorption was not detected within the limit of experimental error.

19943 DETERMINATION OF THE OPTICAL CONSTANTS OF Ge AND CdTe BY THE REFLECTION METHOD.
N.K.Kiseleva and N.N.Pribytkova.
Optika i Spektrosk. (USSR), Vol. 10, No. 2, 266-8 (Feb., 1961).
In Russian.

The refractive index and the absorption coefficient for Ge and CdTe monocrystals were determined by the reflection method. The spectral variation in the constants for Ge agreed quite well with previous transmission measurements, though the absolute values of the constants predicted by the two methods differed. The optical constants for CdTe were measured in the range 330-960 mμ. The refractive index is approximately constant at about 2.6 in the range 500-900 mμ and increases to a maximum of about 2.9 at 400 mμ. The absorption coefficient showed two regions of sharp change at 550 and 400 mμ. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 2, 133-4 (Feb., 1961)]. A.J.Fox

19944 THE OPTICAL CONSTANTS OF CALCIUM FLUORIDE IN THE INFRARED. G.Heilmann.
Z. Naturforsch. (Germany), Vol. 16a, No. 7, 714-6 (July, 1961).
In German.

The optical constants n and k of synthetic single-crystal calcium fluoride were measured by a reflection method in the wavelength range 17 to 38 microns. The maxima of n and k, corresponding to the eigen-vibration, were at a wavelength just beyond 38 microns. J.N.Hodgson

19945 REFLECTIVITY AND OPTICAL CONSTANTS OF INDIUM ARSENIDE, INDIUM ANTIMONIDE, AND GALLIUM ARSENIDE. R.E.Morrison.
Phys. Rev. (USA), Vol. 124, No. 5, 1314-17 (Dec. 1, 1961).

The reflectivities were measured at nearly normal incidence from 2050 A to 15 μ at room temperature. The optical constants were computed from these data in the range 0-6.0 eV using the dispersion relation between the phase and the magnitude of the reflectivity. The reflectivities obtained show peaks near 2.5 and 5.0 eV, with splitting of the lower maxima into two smaller peaks whose separations are 0.35, 0.50, and 0.20 eV, respectively, for InAs, InSb and GaAs. The imaginary part of the reciprocal of the dielectric constant appears to have a maximum beyond 6.0 eV, the magnitudes of this quantity at 6.0 eV being 1.0 for InAs, 1.7 for InSb, and 0.8 for GaAs. These values are uncertain because of the effect of extrapolating the reflectivity to energies above 6.0 eV.

19946 LIGHT SCATTERING BY NEUTRON IRRADIATED SILICA. R.D.Maurer.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 44-51 (Dec., 1960).

The intensity of light scattered by fast-neutron-irradiated fused silica indicates that the damaged volume per primary struck atom is about $(67\ A)^3$. There is dissymmetry of scattering, showing that this small volume is strung out in a long thin, or rodlike, region in order to give interference effects. The angular dependence of scattering for the H_h and V_V components is different and can be accounted for by assuming that strain surrounds the damaged region. Theories of the strain scattering effect are developed to give a quantitative account of the scattering. These indicate how the angular dependence of scattering may be interpreted to discriminate between the effect of strain and the effect of the length of the rodlike regions. The length is found to be approximately 1800 A.

COLOUR IN THE SYSTEM $Al_2O_3-Cr_2O_3$. See Abstr. 20539

19947 REFRACTIVE INDEX OF Cu_2O CRYSTALS IN REGION UP TO 10 μ. J.Pastrňák.
Czech. J. Phys., Vol. 11, No. 5, 374-5 (May, 1961).

The measurements are outlined briefly, and the results are shown graphically. The refractive index varies from about 2.7 at 0.5 μ to about 2.3 at 12 μ. L.M.Roberts

19948 REFRACTIVE INDEX OF SOLID KRYPTON AND [DENSITY OF] SOLID ARGON. B.L.Smith.
Phil. Mag. (GB), Vol. 6, 939-42 (July, 1961).

The refractive index of solid Kr was measured over the range 71°-109°K at the wavelength 5893 A, and the density of solid argon over 77°-83°K. The Lorentz—Lorenz function is plotted for both materials. W.T.Welford

19949 THE REFRACTIVITY AND LIGHT SCATTERING OF CRYSTALS CONTAINING DEFECTS.
E.W.J.Mitchell and J.E.Whitehouse.
Phil. Mag. (GB), Vol. 6, 947-9 (July, 1961).

Refractivity and scattering depend respectively linearly and quadratically on the polarizability of defects and this could be used to estimate the concentration of defects; in an experiment on neutron irradiated quartz, the defect concentration so found was in order-of-magnitude agreement with an estimate from slow neutron scattering data. W.T.Welford

19950 A THEORY OF THE TEMPERATURE DEPENDENCE OF THE DISPERSION AND [EXCITON] ABSORPTION OF LIGHT IN MOLECULAR CRYSTALS. V.L.Strizhevs'kii.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 1, 120-1 (1960). In Ukrainian.

19951 A CONTRIBUTION TO THE THEORY OF THE TEMPERATURE DEPENDENCE OF DISPERSION AND EXCITON ABSORPTION OF LIGHT IN CRYSTALS.
S.I.Pekar and V.L.Strÿzhevs'kÿi.
Ukrayin. fiz. Zh. (USSR), Vol. 5, NO. 2, 277-8 (1960). In Ukrainian.

19952 OPTICAL DOUBLE REFRACTION CAUSED BY FREE CARRIERS IN SEMICONDUCTORS.
K.J.Schmidt-Tiedemann.
Z. Naturforsch. (Germany), Vol. 16a, No. 2, 639 (June, 1961).
In German.

It is shown that the observation of double refraction in semiconductors can yield information concerning the effective mass anisotropies. The measurements coupled with elastic constant and piezoelectric measurements can give further information about the anisotropy of electron relaxation times. C.A.Hogarth

19953 DETERMINATION OF PHOTOELASTIC CONSTANTS IN THE PRESENCE OF TILT OF THE AXES.
K.V.Krishna Rao.
Indian J. Phys., Vol. 35, No. 7, 341-5 (July, 1961).

Describes a direct method of determining the differential stress-optical constants, when the axes of polarization in a stressed crystal do not coincide with the principal directions of stress. The method is verified by studies on barium nitrate and strontium nitrate crystals.

19954 MAGNETO-OPTICAL PROPERTIES OF GADOLINIUM. M.Auphan.
C.R. Acad. Sci. (France), Vol. 253, No. 3, 398-9 (July 17, 1961).
In French.

The variation with temperature of the rotation of the plane of polarization of light from a tungsten source on reflection from a thin film of gadolinium protected by a layer of silicon monoxide was measured. Measurements were made in fields of 4500, 7000 and 9000 G between −50°C and the Curie point. A.J.Manuel

19955 MAGNETO-OPTICAL ABSORPTION SPECTRA IN SEMICONDUCTORS WITH ARBITRARY FORM OF ISOENERGETIC ELECTRON SURFACES. THE CASE OF CLOSED TRAJECTORIES. L.I.Korovin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2202-13 (Aug., 1961).
In Russian.

The magneto-optical absorption spectrum is calculated for direct electron transitions between two zones in a strong magnetic field. The case is considered in which the electron trajectories in one zone occupy a close region in K-space, and cannot be described by a quadratic law of dispersion. For such a transition the selection rule has a complicated form. The absorption spectrum consists of several successions of peaks, overlapping one another, each succession being associated with one quantum number. A calculation is made of the absorption coefficient for single crystal tellurium in a magnetic field whose direction is perpendicular to the optical axis. [English translation in: Soviet Physics—Solid State (USA)].
D.J.Barber

19956 INCREASE OF THE MAGNETO-OPTICAL KERR ROTATION THROUGH INTERFERENCE.
J.Kranz and A.Schauer.
Optik (Germany), Vol. 18, No. 4, 186-200 (April, 1961). In Germa

The magneto-optical Kerr rotation can be increased by mean of suitable evaporated films. The amplification effect of a thin interference film is calculated for the case of meridian magnetization of the ferromagnetic probe and oblique incidence of the light. The theoretical results are discussed and compared with experim

19957 EXCHANGE INTERACTION AND MAGNETO-OPTICAL EFFECTS IN FERRITE GARNETS.
G.S.Krinchik and M.V.Chetkin.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 673-80 (Sept., 196
In Russian.

It is shown that, as well as the Faraday effect due to electron transitions, a similar effect exists which is due to magnetic spin resonance, that is, to precession of the magnetization vector under the action of the magnetic field of the light wave. In ferrite garnet with a magnetoactive rare-earth sublattice this effect is also determined by exchange resonance, that is, by precession of the magnetization vector of one sublattice in the exchange field of the other. In an exchange field of 2.5 × 10^5 Oe, the Zeeman effect of the line $^7F_0 \rightarrow {}^7F_6$ was observed in europium ferrite garnet. In this case the Faraday effect is due to exchange but not to spin—orbit splitting. [English translation in: Soviet Physics—JETP (USA)].

19958 THE INCREASE OF MERIDIAN MAGNETO-OPTICAL KERR ROTATIONS BY EVAPORATED LAYERS.
W.Drechsel.
Z. Phys. (Germany), Vol. 164, No. 3, 308-23 (1961). In German.

The general equations for the effect of an evaporated dielectric layer on the magnitude of the Kerr rotation was derived taking multiple interference into account. Special cases of polarization parallel and perpendicular to the incident plane were calculated and compared with experimental results. A ZnS interference wedge was deposited onto a polished soft iron sample. Thickness was controlled photometrically during evaporation to give a minimum in reflection for light of 5461 A at an incident angle of 67° polarized perpendicular to the incident plane. Measurements along the sample of Kerr rotation and reflected intensity were then made at the same angle for both parallel and perpendicular polarization and found essentially similar to calculated curves. This suggested that the theory was justified in principle though some unexplained differences remained. W.Steckelmacher

19959 ON THE FARADAY EFFECT IN MANY-VALLEY SEMICONDUCTORS. L.Gold.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1471 (July, 1961).

In developing the complete classical electrodynamics for free carriers in many-valley semiconductors, a new relation for the Faraday rotation was deduced. This relationship, unlike earlier ones, reduces in the scalar-mass limit to the Appleton—Hartree formula for an isotropic mass medium. A.J.Fox

19960 REFLECTION SPECTROSCOPY AND SELECTIVE REFLECTION OF COPPER HALIDES AT LOW TEMPERATURES. S.Nikitine and R.Reiss.
J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 237-45 (Nov., 1960).
In French.

It is shown that investigations of reflection spectra of thin solid films at low temperature can give some information about absorptio lines which cannot be observed by transmission, if the crystal available is too thick. It is shown how interference fringes of thin films can be used to obtain dispersion curves of copper halides. These curves are used to evaluate the oscillator strength of the absorption lines using Drude's dispersion theory. A selective reflection curve can also be used to obtain an order of magnitude of the oscillator strength. In the case of a strong absorption line, the reflection spectrum has a maximum (excitonic residual rays) followed by a minimum of shorter wavelength ("missing rays"). It is shown that the edge of a continuous absorption should correspond to a maximum of reflection only near the wavelength of the edge.

19961 SPECTRAL TRANSMITTANCE PROPERTIES OF RARE EARTH GLASSES. C.X.Dodd and T.W.West.
J. Opt. Soc. Amer., Vol. 51, No. 8, 915-16 (Aug., 1961).

Variations with temperature over the range 4°C to 63°C were studied for six glasses containing 5% of oxides of Dy, Er, Ho, Nd, ınd Sm respectively. No wavelength shifts of the transmittance ima were found. W.T.Welford.

9962 LIGHT TRANSMISSION TECHNIQUE FOR FOLLOWING CONTINUOUS CHANGES IN OPTICAL RETARDATION POLYMER FILMS.

J.H.Magill.

t. J. appl. Phys., Vol. 12, No. 11, 618-20 (Nov., 1961).

The light intensities (crossed and parallel polaroids) trans-ted by a spherulitic polymer film of uniform thickness were ısured using a photomultiplier-recorder system. These intensity ısurements were correlated with the optical retardations rek compensator) measured over the same temperature erval. The linear relationship obtained establishes the validity he technique for following changes in optical retardation. ɔical results are given for polyhexamethylene adipamide nylon) and isotactic polypropylene polymer films.

19963 TRANSMITTANCE CHANGES IN GLASSES INDUCED BY ULTRAVIOLET RADIATION.

3oettner and L.J.Miedler.

Opt. Soc. Amer., Vol. 51, No. 11, 1310-11 (Nov., 1961).

Rapid solarization in a Schott u.v. transmitting glass was found be mainly due to wavelengths below 2800 A. W.T.Welford

19964 IRRADIATED LITHIUM FLUORIDE AS AN OPTICAL FILTER IN THE FAR ULTRA-VIOLET.

.Weeks, S.Gordon and G.M.A.C.Meaburn.

ture (GB), Vol. 191, 1186-7 (Sept. 16, 1961).

LiF windows exposed to X- or γ-rays develop an F-centre sorption band near 2420A, and can be used as filters. Curves of ansmission as a function of γ-irradiation are shown for the 1849 and 2537 A lines. For a typical specimen the transmissions ter irradiation were about 40% and $< 0.1\%$. The effect of bleaching u.v. light is small. A.G.Gaydon

19965 SOLID STATE OPTICAL MASER USING DIVALENT SAMARIUM IN CALCIUM FLUORIDE.

.P.Sorokin and M.J.Stevenson.

3M J. Res. Developm. (USA), Vol. 5, No. 1, 56-8 (Jan., 1961).

A new maser system is described which resembles that of ivalent uranium in calcium fluoride (Abstr. 3873 of 1961). The ıergy-level system approaches the ideal necessary for c.w. maser ɔeration. J.Sheridan

19966 THE ABSORPTION AND REFLECTION OF LIGHT, AND THE NATURE OF THE OPTICAL ELECTRON RANSITIONS IN CRYSTALS OF Cu_2O.

I.Pastrnyak.

iz. tverdogo Tela (USSR), Vol. 3, No. 3, 869-75 (March, 1961). ı Russian.

The absorption and reflection spectra of crystalline Cu_2O in the icinity of the absorption edge were measured at 77°K. The value f the absorption coefficient, and the relative intensities of the bsorption lines for n = 2 and 3 of the yellow exciton series, are aken as evidence for the occurrence of forbidden transitions in he absorption process. The presence of two exciton series, and wo regions of structure in the reflection spectrum is explained y a splitting of the valence band. The observed steps on the ong-wavelength side of the fundamental absorption edge and in the = 2 line of both exciton series is shown to be due to the simultıneous absorption of a phonon of energy 0.027 eV. [English ranslation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 333-7 (Sept., 1961)]. K.N.R.Taylor

19967 THE QUADRUPOLE ABSORPTION COEFFICIENT AND THE OPTICAL LIFETIME OF THE GROUND STATE OF EXCITONS IN A Cu_2O CRYSTAL.

E.F.Gross and A.A.Kaplyanskii.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 75-8 (July 1, 1961). In Russian.

For abstract, see Abstr. 17876 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 7, 592-4 (Jan., 1961)].

19968 THE ABSORPTION OF THE DEFECTS IN SILVER BROMIDE WITH THE ADDITION OF DIVALENT IMPURITY IONS.

I.Kunze and O.Stasiw.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 10, 598-601 (1960). In German.

The absorption spectra of the doped crystals AgBr(S), AgBr(Se) and AgBr(Te) was measured at −250°C. Near the fundamental absorption edge two additional absorption lines were observed and the corresponding photon energies recorded. The splitting of absorption lines in the crystalline field is discussed. Possible complexes to account for the absorption in the case of AgBr(S) are suggested. A.J.Fox

19969 ON THE ABSORPTION BY IRRADIATED SILVER HALIDE CRYSTALS DOPED WITH CHALCOGEN IONS.

A.Scholz and O.Stasiw.

Z. Phys. (Germany), Vol. 164, No. 4, 431-41 (1961). In German.

Previous experimental results on the optical absorption bands produced by X-ray irradiation of sulphur-doped silver bromide crystals are summarized. The positions and thermal behaviour of the bands are explained theoretically on the basis of a simplified model. J.N.Hodgson

19970 THE OPTICAL ABSORPTION EDGE OF GALLIUM ARSENIDE.

M.V.Hobden and M.D.Sturge.

Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 615-16 (Oct., 1961).

The optical absorption edge of semi-insulating gallium arsenide was investigated at 290°, 77° and 20°K. At the lower temperatures, the absorption showed a distinct peak followed by a region of slowly increasing absorption. The peak is interpreted as absorption due to direct transitions to bound exciton states at the centre of the Brillouin zone and the slowly increasing absorption as that due to unbound electron—hole pairs. A.J.Fox

19971 THE EFFECT OF THE MAGNETIC FIELD INVERSION ON THE EXCITON ABSORPTION SPECTRUM OF A CdS CRYSTAL.

E.F.Gross, B.P.Zakharchenya and O.V.Konstantinov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 305-7 (Jan., 1961). In Russian.

Describes the differences found in the splittings of the 4813 and 4814 A lines for two directions of the magnetic field perpendicular to the optic axis of a single crystal 1-3 μ thick. It is shown that this can occur for an exciton state with a dipole moment in a crystal without an inversion centre. The effect does not occur for the field parallel to the optic axis. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 1, 221-2 (July, 1961)]. R.Berman

19972 THE EFFECT OF AN H.F. ELECTRIC FIELD ON THE FUNDAMENTAL ABSORPTION EDGE IN SILICON.

K.I.Britsȳn and V.S.Vavilov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2497-9 (Aug., 1961). In Russian. English translation in: Soviet Physics—Solid State (USA).

OPTICAL ABSORPTION BY A SUBSTITUTIONAL IMPURITY IN SOLID NEON. See Abstr. 19747

ABSORPTION OF ELECTROMAGNETIC RADIATION BY AN ELECTRON GAS. See Abstr. 19750

INFRARED ABSORPTION AND THE STRUCTURE OF GLASSES. See Abstr. 20636

OPTICAL ABSORPTION OF GaAs FILMS. See Abstr. 20668

SPECTRA OF NaCl-TYPE CRYSTALS. See Abstr. 19691

19973 ENERGY LEVELS OF $PrCl_3$.

J.S.Margolis.

J. chem. Phys. (USA), Vol. 35, No. 4, 1367-73 (Oct., 1961).

A review of the spectra of the Pr^{3+} ion in $PrCl_3$ is presented and the spectra are reanalysed by means of a more complete Hamiltonian than has been previously used. This new Hamiltonian includes a complete calculation of the crystalline field interaction for a field of D_{3h} symmetry, and the first-order calculation of the orbit—orbit, mutual spin—orbit, and spin—spin interactions, as well as the usual spin—orbit and mutual electrostatic interactions. The multiplet splitting and crystalline field splitting are treated separately according to a least-squares procedure; the standard deviation of the centre of gravity of the multiplets is 200 cm^{-1} without the orbit—orbit interaction and 105 cm^{-1} with it. The values of F_2, F_4, F_6, ζ, and α are 305.4, 51.88, 5.321, 729.5, –, cm^{-1}, respectively, in the first case, and 307.9, 50.23, 5.033, 755.1, −0.6542, cm^{-1}, respectively, in the second case. The standard deviation of the calculation for 40 of the crystalline field levels is 7 cm^{-1}. If the deviation of the $^1D_2$ levels, which fit the calculation particularly badly, are not included, the standard deviation is then only 4 cm^{-1}. The values of the crystalline field parameters are: $A_{20} \langle r^2 \rangle = =47.26$, $A_{40} \langle r^4 \rangle = -40.58$, $A_{60} \langle r^6 \rangle = 39.62$, $A_{66} \langle r^6 \rangle = 26.67\ cm^{-1}$.

19974 SPECTRUM AND MAGNETIC PROPERTIES OF HEXAGONAL $DyCl_3$. H.M.Crosswhite and G.H.Dieke.
J. chem. Phys. (USA), Vol. 35, No. 5, 1535-48 (Nov., 1961).

The absorption and fluorescence spectra of anhydrous $DyCl_3$ were investigated and the levels up to 37 000 cm^{-1} above the ground state established. Conclusive evidence is presented that the levels below 15 000 cm^{-1} belong to the ^6H and ^6F multiplets. The Zeeman effects show considerable nonlinear interactions which follow quantitatively the existing theory. The 12 low levels and their electric and magnetic field splittings are reasonably well represented by the simplified theory with L-S coupling, with the approximate crystal parameters $B_2{}^0 = A_2{}^0 \langle r^2 \rangle = 89.8\ cm^{-1}$, $B_4{}^0 = -40.0\ cm^{-1}$, $B_6{}^0 = -23.3\ cm^{-1}$, $B_6{}^6 = 253\ cm^{-1}$.

19975 CRYSTAL SPECTRA OF METAL COORDINATION COMPOUNDS. VI. BIS-SALICYLALDIMINATO-COPPER (II) AND BIS-N-METHYL-SALICYLALDIMINATO-COPPER (II). J.Ferguson.
J. chem. Phys. (USA), Vol. 35, No. 5, 1612-16 (Nov., 1961).

For Pt V, see Abstr. 11373 of 1961. The polarized crystal absorption spectra of bis-N-methylsalicylaldiminato-copper (II) and bis-salicylaldiminato-copper (II) are reported. In each case measurements were made with two different crystal faces. An analysis of the spectra shows that the ligand field is rhombic (D_{2h}) and the in-plane symmetry axes do not lie along metal-ligand bonds but between them, as reported previously for the corresponding nickel compounds. The effect of copper-copper interaction in the crystal is briefly discussed.

19976 POLARIZED VISIBLE SPECTRA OF CRYSTALLINE TRISOXALATOMETALLATES.
T.S.Piper and R.L.Carlin.
J. chem. Phys. (USA), Vol. 35, No. 5, 1809-15 (Nov., 1961).

The absorption of polarized light by single crystals of $NaMgAl(C_2O_4)_3.9H_2O$ with part of the aluminium isomorphously replaced by the trivalent ions of Ti, V, Cr, Mn, Fe, and Co is reported. Assignments of the observed transitions are made. The polarizations prove that both the spin-allowed and spin-forbidden transitions are electric dipolar. They are made allowed by the static asymmetric ligand field and not by coupling to vibrations. The trigonal field strength is evaluated in terms of the parameter K which is found to range from −350 to +500 cm^{-1}.

19977 ANALYSIS OF THE ABSORPTION SPECTRUM OF $YbCl_3.6H_2O$. J.C.Eisenstein.
J. chem. Phys. (USA), Vol. 35, No. 6, 2097-2100 (Dec., 1961).

The measurements of Dieke and Crosswhite (Abstr. 243 of 1957) on the absorption spectrum of $YbCl_3.6H_2O$ are discussed. Their interpretation of the spectrum is extended by the identification of two of the weaker lines. The entire spectrum is considered on the basis of crystal-field theory, and the possibility of determining the parameters of the crystal-field potential is assessed. It is suggested that this compound may be ferroelectric (or antiferroelectric). The spin-orbit coupling constant is determined to be −2924 cm^{-1}.

19978 EMISSION SPECTRA OF MIXED CADMIUM AND ZINC SULPHIDES ACTIVATED WITH SILVER: THE EXISTENCE OF TWO EMISSION BANDS. H.Payen de la Garanderie.
J. Phys. Radium (France), Vol. 22, No. 7, 428-34 (July, 1961).
In French.

Two main emission bands are observed in the spectra of the Cu- and Au- activated Zn and Cd sulphides. The same is true for CdS(Ag). But ZnS(Ag) appeared as an exception. The present work gives evidence for the occurrence of both bands in ZnS(Ag) also, supporting previous indications by Henderson and co-workers (Abstr. 3316 of 1959). The displacement of these bands was studied in the mixed crystals ZnCdS(Ag), leading to their accurate identification.

19979 HYPERFINE STRUCTURE OF PRASEODYMIUM IN SOLIDS. Y.Ayant and E.Belorizky.
J. Phys. Radium (France), Vol. 22, No. 7, 460-2 (July, 1961).
In French.

Praseodymium has a single isotope with a structure suitable for the experimental study of hyperfine structure. The structures of the Pr^{4+} and Pr^{3+} ions are considered in a purely cubic structure. In the case of the Pr^{4+} ion the hyperfine structure arising from the fundamental electronic Γ_8 level is calculated and shown to consist of two single, two double, and six triple levels. A similar analys is presented for the electronic triple Γ_5 level of the Pr^{3+} ion.

J.W.Ta

19980 OPTICAL PROPERTIES OF IRRADIATED LiF CRYSTALS IN THE EXTREME ULTRAVIOLET REGI
R.Kato, S.Nakashima, K.Nakamura and Y.Uchida.
J. Phys. Soc. Japan, Vol. 15, No. 11, 211-12 (Nov., 1960).

Absorption spectra of LiF single crystals irradiated with β or γ rays were extended down to 900 A. A band at 11.1 eV, well separated from the fundamental band was observed. Faint bands at 10.7 and 9.5 eV were also observed. In some specimens a shoulder indicated the presence of a band at 11.75 eV. After bleaching of the specimen with F light, the band at 11.1 eV decreased, the absorption at 11.75 eV increased and a band at 222 mμ appeared. The 222 mμ band appeared strongly in the specimen which was quenched to room temperature after β irradiation at 350° C. A broad band from 6 to 8.5 eV also appeare on β irradiation. This band disappeared on irradiation with F ligh

S.C.Ja

19981 OSCILLATOR STRENGTH OF I^--ABSORPTION BAND IN KCl CRYSTAL. T.Ishii.
J. Phys. Soc. Japan, Vol. 16, No. 8, 1640 (Aug., 1961).

Measurement of the absorption band at 188.5 mμ in KCl crystals containing KI and subsequent determination of I^- ions by chemical analysis gave $f = 0.30 \pm 0.04$. The calculation was made using Smakula's formula.

A.G.Gayd

19982 THE EXCITON SPECTRUM OF ZINC OXIDE. D.G.Thomas.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 86-96 (Aug., 1960).

The absorption and reflection spectra of ZnO crystals were observed in the near ultraviolet at temperatures between 300° and 4.2°K. At 77°K three well-marked reflection peaks occur: two fo light polarized with $E \perp c$ (c is the hexagonal axis) and one for $E \parallel c$ The reflectance data were analysed by means of the Kramers–Kronig relation. The three peaks arise from n = 1 exciton transiti involving holes from each one of the three valence bands. At 4.2° the n = 2 exciton states become apparent in reflection, allowing estimates to be made of the exciton binding energy and reduced mass. In absorption the lowest energy exciton may be seen in the "wrong" mode of polarization indicating mixing of certain exciton states. Longitudinal excitons and various forbidden transitions are also observed together with a considerable number of "impurity" exciton transitions. At 4.2°K sharp fluorescent lines occur which are associated with the impurity effects. Zeeman effects were see in a field of 32 000 G.

19983 FINE STRUCTURE IN THE OPTICAL ABSORPTION EDGE OF ANISOTROPIC CRYSTALS. J.J.Hopfield.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 97-107 (Aug., 1960).

The group theory of weakly bound direct excitons is developed without explicit use of effective mass theory. For the usual case in which the direct band gap occurs at a point of high symmetry, direct exciton wave-functions can be expanded in one-electron wave-functions which have the symmetry of this point. The expansion is the k-space analogue to the expansion of a tightly bound exciton envelope wave-function in real space. A quasi-cubic model of the valence band structure for hexagonal ZnO, CdS and ZnS is develope The model, in conjunction with the group theory of weakly bound excitons, explains on a semi-quantitative basis most of the observe exciton fine structure in ZnO and CdS. A theorem which aids in constructing higher order "Kubic harmonics" (for any point group is given in an appendix.

19984 THE EFFECT OF PRESSURE ON THE ABSORPTION SPECTRA OF ALKALI HALIDE PHOSPHORS.
R.A.Eppler and H.G.Drickamer.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 112-18 (Aug., 1960).

The effect of pressure (over 150 000 atm) was measured on the spectra of twenty-six alkali halide phosphors including nine doped with Tl^+, two doped with In^+, twelve doped with Pb^{2+}, two doped wit Cu^{2+} and one doped with Bi^{3+}. ν_{max} for the Tl^+ doped phosphors depends very strongly on the crystal structure and very little, if any, on the halide ion involved, which is consistent with the Seitz model. The In^+ doped phosphors behave like the Tl^+ analogues. Fo the Pb^{2+} phosphors, the shift of ν_{max} depends very strongly on the halide ion, and only incidentally on the lattice structure. This is consistent with the complex model.

19985 THEORY OF THE ABSORPTION EDGE IN SEMICONDUCTORS IN A HIGH MAGNETIC FIELD.
J.Elliott and R.Loudon.
Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 196-207 (Oct., 1960).

A theory based on the effective mass approximation is given hole—electron pairs in a semiconductor in a magnetic field. e intensity of the absorption edge is determined by the wave-nction of relative motion of the pair, so that essentially it comes neccessary to solve the Schrődinger equation for a drogen atom in a magnetic field. This is done in an approximation valid in high fields which assumes that the Coulomb term fects only the motion along the field, and uses a potential form hich allows the solutions to be written in terms of confluent pergeometric functions. The results show that the main intensity each magnetic sub-band transition is thrown into the lowest citon line and that the absorption in the continuum is reduced to insignificant shoulder. The peaks observed in the so-called agneto-optic effect will all be exciton peaks.

19986 OPTICAL ABSORPTION AND ENERGY LEVEL STRUCTURE OF CUPROUS OXIDE. I.S.Gorban'.
rayin. fiz. Zh. (USSR), Vol. 5, No. 2, 281-4 (1960). In Ukrainian.

Reports measurements of the absorption spectrum near the ndamental edge and deduces that the valence band is split into ree sub-bands.

19987 SPECTRUM, ZEEMAN EFFECT AND ELECTRON LEVELS OF TRIVALENT HOLMIUM IN CRYSTALLINE ALTS. I.Grohmann, K.H.Hellwege and H.G.Kahle.
Phys. (Germany), Vol. 164, No. 3, 243-56 (1961). In German.

The absorption spectrum of Ho^{3+} ions in hexagonal ethyl ulphate, in the triclinic nitrate and the monoclinic water-containing hloride, and the Zeeman effect in ethyl sulphate were measured and nalysed at low temperatures (4.2°K). The previous analysis of e chloride spectrum was corrected. The J-values and Landé g-ctors were estimated for all the electron energy levels concerned.

C.A.Hogarth

19988 INFLUENCE OF AN ELECTRIC FIELD ON THE ABSORPTION EDGE OF ZnS.
Damašková and K.Pátek.
Phys. (Germany), Vol. 164, No. 4, 428-30 (1961). In German.

As shown theoretically by Franz and Keldysh (Abstr. 6822 and 827 of 1958), there is an absorption edge shift towards longer wave-engths in crystals under an electric field. A first report on the ffect in ZnS single crystals is presented.

CRYSTAL SPLITTING OF THE ANTHRACENE 3800 A YSTEM. See Abstr. 19639

19989 INFRARED ABSORPTION SPECTRUM OF PHOTOGENERATED FREE CARRIERS IN SILICON.
T.Staflin and L.Huldt.
Ark. Fys. (Sweden), Vol. 20, Paper 37, 527-38 (1961).

The infrared absorption in silicon due to free electrons and holes was measured in the wavelength interval 1-30 μ and temperature interval 80-520°K. Excess carriers were excited by illumination of light with quantum energy greater than the fundamental band gap. The density of excess carriers was determined by measuring their mean lifetime. The dependence of the absorption coefficient on wave-number and temperature is essentially in agreement with the theory of Fan, Spitzer and Collins (Abstr. 2101 of 1956), as well as with the more refined theories of Meyer (Abstr. 4458 of 1959) and of Rosenberg and Lax (Abstr. 4582 of 1959).

19990 EFFECT OF TEMPERATURE ON THE INTENSITY AND STRUCTURE OF BANDS IN THE INFRARED SPECTRUM OF RHOMBIC SULFUR. V.D.Neff and T.H.Walnut.
J. chem. Phys. (USA), Vol. 35, No. 5, 1723-9 (Nov., 1961).

The infrared spectrum of rhombic sulphur was obtained in the region between 750 and 2000 cm^{-1}. The relative intensities of the bands at 845, 936, 1298, and 1513 cm^{-1} were measured as a function of temperature and sample orientation from −190° to 85°C. An expression is given that relates the temperature dependence for an overtone or combination band to the values of the component frequencies. The expression is used in conjunction with the measured temperature dependence to reject some previous assignments and to establish rough values of the component frequencies in the observed overtone and combination bands. A tentative assignment consistent with the rough values found for the component frequencies is made. In addition, the structure of a band is considered to be the result of combination with acoustic lattice modes, and the temperature dependence of the structure is analysed from this point of view. The temperature dependence of the intensity of the structure of the band at 845 cm^{-1} far from the peak agrees roughly with the expression obtained, but the dependence close to the peak does not.

19991 AN ANALYSIS OF THE INFRARED ABSORPTION SPECTRUM OF $Am^{+3}(5f^6)$ IN $LaCl_3$. J.B.Gruber.
J. chem. Phys. (USA), Vol. 35, No. 6, 2186-92 (Dec., 1961).

The polarized infrared absorption spectrum of single crystals of $Am^{3+}(5f^6)$ in $LaCl_3$ was studied from 0.79 to 16.0 μ. In almost every instance the spectrum is sharp and completely polarized, and appears in definite groupings. Transitions from the ground level, $^7F_0$, to excited levels of the ground term, $^7F_1$, $^7F_2$, $^7F_3$, $^7F_4$, $^7F_5$, and $^7F_6$ were observed. For the particular point symmetry C_{3h} that is consistent with experiment, magnetic-dipole transitions are observed from the $^7F_0$ level to the $^7F_1$ level, and forced electric-dipole transitions are observed to levels J = 2, 3, 4, 5, and 6. A theoretical analysis is presented for the crystal-field split ^7F_J levels. Using four parameters — $A_2^0\langle r^2\rangle = 206$ cm^{-1}, $A_4^0\langle r^4\rangle = -94.1$ cm^{-1}, $A_6^0\langle r^6\rangle = -93.8$ cm^{-1}, and $A_6^6\langle r^6\rangle = 1100$ cm^{-1} — excellent agreement is obtained between theory and experiment.

19992 INFRARED ABSORPTION BY ONE-DIMENSIONAL IONIC LATTICES. H.B.Rosenstock.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 50-3 (Aug., 1961).

The absorption spectrum due to the atomic motion in a one-dimensional ionic lattice, considered to consist of point particles of equal mass and alternating charge with Coulomb interaction and nearest-neighbour repulsion, is found to consist of a line of shape

$$[-\ln(\omega_{\max} - \omega)]^{1/2}/(\omega_{\max} - \omega)^{3/2}.$$

19993 SOME OPTICAL AND ELECTRICAL PROPERTIES OF SEMICONDUCTING DIAMONDS.
A.Halperin and J.Nahum.
J. Phys. Chem. Solids (GB), Vol. 18, No. 4, 297-306 (March, 1961).

Two semiconducting (Type IIb) diamonds were examined for some of their optical and electrical properties. The energies of the extra absorption bands in the infrared typical to Type IIb specimens were found to fit very well the thermal activation energies obtained both from the dark conductivity and the thermoluminescence. The experiments indicate discrete levels of 0.21, 0.30, 0.37, 0.52 and about 0.7 eV above the valence band. Nearly the same spectral distribution was found for the u.v. excited luminescence, the electroluminescence, and the thermoluminescence, all having their main maximum at about 0.48 μ. Excitation spectra for the thermoluminescence and the photoconductivity were also measured. Some other experiments describe the conductivity and voltaic glow curves of the same specimens.

19994 INFRARED ABSORPTION OF GERMANIUM AND SILICON SINGLE CRYSTALS. R.Ritschl and A.Röseler.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 11, 690-1 (1960). In German.

19995 TWO-PHONON INFRARED LATTICE ABSORPTION IN DIAMOND. J.R.Hardy and S.D.Smith.
Phil. Mag. (GB), Vol. 6, 1163-72 (Sept., 1961).

The specimen-independent infared absorption spectrum of diamond in the 2 μ to 6 μ region was examined using a grating spectrometer. The results were analysed in terms of multiphonon processes. In particular the two-phonon absorption was examined in detail in an attempt to deduce phonon energies for the various branches of the frequency spectrum at symmetry points in the reduced zone. Sets of lattice wave dispersion curves were constructed from these results and are very unlike those for silicon and germanium.

19996 TEMPERATURE VARIATION OF OPTICAL ENERGY GAP FOR GaSb—InSb ALLOYS.
J.C.Woolley and J.A.Evans.
Proc. Phys. Soc. (GB), Vol. 78, Pt 3, 354-60 (Sept., 1961).

Reasonably homogeneous, polycrystalline, solid ingots of GaSb—InSb alloys were produced by slow directional freezing techniques (Abstr. 6120 of 1960; 7652 of 1961). For alloys of various compositions, normal absorption measurements were made to determine the variation of optical energy gap E_g with temperature in the range 100-800°K. It is found that the alloys show a linear variation of E_g with temperature, and values of extrapolated absolute-zero energy gap and energy gap temperature coefficient are obtained. These results are compared with previous data from electrical measurements and the question of the variation with composition of the band form of the alloys is discussed.

ABSORPTION OF CRYSTALLINE ALKALI HALIDES BETWEEN 250 AND 650 μ. See Abstr. 18596

TORSIONAL ABSORPTION SPECTRA OF LONG-CHAIN SUBSTANCES IN THE SOLID STATE. See Abstr. 19628

OPTICAL PROPERTIES OF $InAs-In_2Te_3$ ALLOYS. See Abstr. 19880

OPTICAL PROPERTIES OF $InAs-In_2Se_3$ AND $InSb-In_2Se_3$ ALLOYS. See Abstr. 19881

19997 RAMAN SCATTERING IN CRYSTALS.

L.N.Ovander.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2394-2400 (Aug., 1961). In Russian.

The Raman scattering of light by crystals is investigated, using a method due to Agranovich (Abstr. 19451 of 1960). The energy matrix of the interaction contains, besides the generalization of a well-known formula, two small terms, one, identified with coupling in the presence of molecular interactions, e.g. piezoelectric effects, being important at all frequencies, the other being significant only in the X-ray region. [English translation in: Soviet Physics—Solid State (USA)]. G.E.Murphy

19998 CONTRIBUTION TO THE STUDY OF GOLD, PALLADIUM AND THEIR ALLOYS BY X-RAY SPECTROGRAPHY

C.Mandé.

Ann. Phys. (France), Vol. 5, No. 11-12, 1559-1614 (Nov.-Dec., 1960). In French.

Reports a comprehensive study of the behaviour of the loosely bound electrons and the distribution of the unoccupied states of these metals. The study includes L and M edge discontinuities, the $L\beta_5$ band for gold and K and L discontinuities of palladium. The results indicate that a curved-crystal spectrometer is superior to a double-crystal spectrometer for this work. A.E.I. Research Laboratory

19999 THE X-RAY L-ABSORPTION SPECTRA OF 48 Cd—52 Te.

B.Nordfors and E.Noreland.

Ark. Fys. (Sweden), Vol. 20, Paper 1, 1-23 (1961).

The L-absorption spectra of the elements 48 Cd—52 Te were studied, using a bent crystal vacuum spectrometer and a proportional counter. The method was to measure the absolute values of the mass absorption coefficient in a 40-60 eV region around each of the three L-edges of these elements. The results are published in the form of curves. The wavelengths and energies of the absorption limits were measured. The fine structure is briefly discussed.

20000 A DISCUSSION OF THE L-ABSORPTION SPECTRA OF 47 Ag—52 Te.

B.Nordfors.

Ark Fys. (Sweden), Vol. 20, Paper 2, 25-40 (1961).

Recent recordings of the L-absorption spectra of 47 Ag—52 Te are compared with measurements of electronic energy levels using the photoelectron method. It is found that at the absorption edge the energy of the lowest inflection point of the absorption coefficient function agrees within the limits of error (around 0.4 eV) with the binding energy of the electrons in the corresponding level. The consequences of this, regarding the formation of excited states and the overlapping of wave functions in the conduction band, are discussed. The oscillator strengths for the L-levels of 47 Ag—52 Te, and the absorption jumps, are calculated.

20001 CRITICAL POTENTIALS OF SOFT X-RAYS EMITTED FROM NICKEL.

H.Kawaharada.

Sci. Rep. Tohoku Univ. First Ser. (Japan), Vol. 43, No., 3, 143-7 (Oct., 1959).

Thomas (1925) has measured 42 critical potentials of soft X-rays emitted from metallic nickel in the range of applied voltage 0-350 V. In the present paper, these critical potentials are explained according to Hayasi's theory (1943) of the fine structure of sof X-ray absorption spectrum. The fine structures of K- and $M_{II,III}$-absorption spectra for nickel have already been reported (Abstr. 17716 of 1960). From these the energies of quasi-stationa states for nickel can be determined, and the excitation voltages th bring the core electrons of s (or p) symmetry to quasi-stationary states of p (or s, d) symmetry respectively can be estimated. Th estimated excitation voltages are compared with the measured critical potentials and a fair agreement between them is found, which shows that the critical potentials are in a close connection with the quasi-stationary states.

20002 INFLUENCE OF VERY SMALL ADMIXTURES OF ANTIMONY ON THE L SERIES OF THE X-RAY SPECTRUM OF Ge.

M.I.Korsuns'kii and G.P.Borovikova.

Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 1, 88-93 (1960). In Ukrainian

It was reported [Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 23, No. 564 (1959)], that very small admixtures of Fe, Co, Ca and Sb exert a considerable effect on the L series of the X-ray spectrum of Ge. The aim of this study was to ascertain the relation between the con centration of antimony and the value of $\Delta E_{\beta_6-\alpha_{1,2}}$ where

$$\Delta E_{\beta_6-\alpha_{1,2}} = (E_{\beta_6-\alpha_{1,2}})_{Ge+Sb} - (E_{\beta_6-\alpha_{1,2}})_{Ge}$$

and

$$E_{\beta_6-\alpha_{1,2}} = h\nu_{L_{\beta_6}} - h\nu_{L_{\alpha_{1,2}}}$$

An examination of the L series of the X-ray spectrum was made by means of a high vacuum X-ray spectrograph with a bent crystal of mica and photorecording of the spectrum. The dispersion of the spectrograph was 32 X/mm or 3.68 eV/mm. It was shown that: (1) The admixture in the Ge monocrystal of $10^{-3} - 10^{-2}$ at.% antimony displaces the spectral line $L\beta_6$ about $L\alpha_{1,2}$ and $L\gamma_5$ about $L\beta_6$ by 1-2 eV. (2) The value of $\Delta E_{\beta_6-\alpha_{1,2}}$ is proportional to $\sqrt[3]{n}$, where n is the atomic concentration of Sb. (3) The spectral lines $L\alpha_{1,2}$ and $L\beta_6$ are also displaced. This indicates displacement of the $M_{IV,V}$ levels about $L_{II,III}$, but the displacement is smaller than the displacement of N_I about $N_{IV,V}$. (4). The width of the lines $L\alpha_{1,2}$, $L\beta_6$, $L\beta_1$, $L\gamma_5$ depends upon the concentration of Sb, and is a linear function of $\sqrt[3]{n}$.

Luminescence

20003 THE INFLUENCE OF TEMPERATURE ON THE DEPENDENCE OF THE SPECTRAL COMPOSITION OF LUMINESCENCE ON THE INTENSITY OF EXCITATION.

I.Soudek.

Czech. J. Phys., Vol. 11, No. 5, 373-4 (1961). In German.

Preliminary results show that for the two activated sulphide phosphors used the spectral composition is hardly affected in the range 150° to 250° K, but that above and especially below this range the effect is marked. F.Ansbache

INFRARED DETECTORS BASED ON PHOSPHORS. See Abstr. 16153

BARIUM-TITANIUM-PHOSPHATE PHOSPHOR. See Abstr. 2056

PULSE SHAPE DISCRIMINATION AND ENERGY RESPONSE OF CALCIUM TUNGSTATE CRYSTALS. See Abstr. 19062

20004 THE LUMINESCENCE SPECTRA OF DIAMOND.

A.Jayaraman.

Proc. Indian Acad. Sci. A, Vol. 52, No. 5, 189-96 (Nov., 1960).

Studied at liquid-air temperature (80° K). Apart from the two well-known electronic frequencies at λ 4152 and λ 5034 and the associated band systems, the existence of three new electronic emissions was revealed, centred at λ 4958, λ 5106 and λ 5786, which come out with great intensity along with the vibrational bands excited by them. Numerous sharp electronic lines also appear in the spectrum of some of the diamonds. Greatly improved records of the vibration spectrum associated with the λ 4152 emission were obtained and the vibration frequencies deduced from them agree closely with the frequencies evaluated on the is of Raman's theory of lattice dynamics. The investigation eals that the λ 4152, λ 4958, λ 5034 and λ 5786 emissions can st independently and that the colour of luminescence depends hich of these emissions is the principal one in a particular mond. In diamonds exhibiting a white luminescence, λ 4152 and 034 emissions appear in equal strength. The effect of temper- re on the sharpening of the electronic frequencies is found to greater for emissions occurring at greater wavelengths.

0005 THE SPECTRAL DISTRIBUTION OF QUANTUM YIELD OF INFRARED LUMINESCENCE OF Cu_2O AT LOW MPERATURES. J.Pastrňák.

ech. J. Phys., Vol. 11, No. 6, 452-3 (1961). In Russian.

The spectral dependence of the luminescence and photo- ductivity in Cu_2O crystals was observed at 77° K. Maxima in the toconductivity spectrum correspond to absorption in the yellow green exciton series. The luminescence spectrum has a broad ximum, falling off rapidly above 6100 A. A long wavelength tail urs above this edge, which corresponds to some of the exciton es in the photoconductivity spectrum. K.N.R.Taylor

LUMINESCENT CENTRES INDUCED IN LITHIUM FLUORIDE X-RAY IRRADIATION. See Abstr. 20051

20006 LUMINESCENCE IN KI:Tl.

J.E.Alderson and S.E.Williams.

stral. J. Phys., Vol. 14, No. 3, 368-80 (Sept., 1961).

Freshly cleaved single crystals of KI:Tl containing various ncentrations of Tl were irradiated in a vacuum monochromator the 2800-1100 A region at temperatures between −140° and 45° C. e relative luminescence efficiencies in the Tl absorption bands and host crystal fundamental absorption show that energy is ansferred from the host crystal to the impurity centre to produce minescence at room temperatures. To the high energy side of a reshold, which appears to depend on activator concentration, the minescence efficiency is superlinear above about 15° C for Tl (0.0005%). Luminescence production shows a slow build-up hich is analysed in detail for irradiation at 1608 and 1216 A. The ild-up curve is found to have the form

$$L_t = L_s\{A(1 - e^{-yt}) + B(1 - e^{-zt})\},$$

ere L_s is the saturation luminescence, L_t the luminescence t conds after illumination starts, and A, B, y, and z are parameters sociated with two processes for luminescence production involving combination and the attainment of equilibrium in the filling of traps. e efficiency of the first process is superlinear and of the second proximately linear. As in the case of AgBr—AgI examined by oser and Urbach (Abstr. 7014 of 1957) there is no observable osphorescent decay. Thermal escape from traps followed by radia- onless de-excitation was observed by investigating the changes of e instantaneous component of luminescence production with varying tervals of darkness. An explanation is proposed in terms of the igration of holes from shallower to deeper traps ear luminescence ntres followed by recombination with free electrons.

20007 TEMPERATURE DEPENDENCE OF THE ULTRA-VIOLET AND VISIBLE PHOSPHORESCENCE IN KCl:Tl.

V.Joshi.

hysica (Netherlands), Vol. 27, No. 12, 119-28 (Dec., 1961).

The ultraviolet and visible phosphorescence decays of KCl:Tl hosphors were studied at room temperature and at various low emperatures. Other measurements included saturation effects. he present investigations, in conjunction with the author's earlier ork, indicate that u.v. and visible phosphorescence have their rigin in separate species of Tl centres.

LUMINESCENCE OF APATITE HALOPHOSPHATES ON LEACHING OF COLOUR CENTRES. See Abstr. 17569

20008 THE LUMINESCENCE OF AgCl CRYSTALS DOPED WITH THALLIUM. Z.Berger.

Czech. J. Phys., Vol. 11, No. 1, 74-5 (1961).

Single crystals of AgCl containing 0.5 mol.% TlCl, irradiated y 3650A at −180° C, show emission bands with peaks at 4700A (due to pure AgCl), 6100 and 6600A (due to Tl). Prior irradiation at 20° C increases the relative amount of impurity luminescence at −180° C. Near room temperature a slight emission with peak 5650A was observed by a phosphoroscope technique.

S.T.Henderson

20009 REMARK ON THE PROCESS OF LUMINESCENCE IN AgCl SINGLE CRYSTALS. K.Vacek.

J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 337-9 (Nov., 1960). In German.

The two series of small emission bands observed at low temper- ature, which have edges at 4640 and 5080 A and overlap to form the main emission band, are considered to arise from trapping at normal cation vacancies, or at cation vacancies located at dislocations. Either excitons or holes may be trapped at these sites. An energy band model is given which accords with the fluorescence data and the glow curve peaks. S.T.Henderson

20010 LUMINESCENCE OF PURE AND DOPED CRYSTALS OF AgCl AT LOW TEMPERATURES.

K.Vacek and J.Ringeissen.

J. Phys. Radium (France), Vol. 22, No. 8-9, 519-20 (Aug.-Sept., 1961). In French.

The luminescence of crystals of AgCl, AgCl + 0.01 mol % $CdCl_2$ and AgCl + 0.5 mol % TlCl was measured at liquid nitrogen and helium temperatures. A displacement of the emission band at about 4800 A was observed at 77° K as a function of the doped ion. The emission in the red region of the luminescence spectrum disappears at 4° K and the fundamental emission band is displaced towards longer wavelengths.

20011 THE X-RAY LUMINESCENCE OF THE CRYSTAL NaCl:Fe. J.Trnka and M.Lébl.

Czech. J. Phys., Vol. 11, No. 5, 285-7 (1961). In German.

The material crystallized from aqueous solution shows a yellow luminescence which decreases to zero with increase of temperature. Cooling from about 200° C restores the luminescence, but not from higher temperatures. S.T.Henderson

20012 RADIO-LUMINESCENCE IN SODIUM CHLORIDE AND POTASSIUM CHLORIDE.

S.B.Hyder and B.K.Gupta.

Nature (GB), Vol. 192, 60-1 (Oct. 7, 1961).

The dependence of the intensity of the luminescence excited in sodium and potassium chloride by 30 keV X-rays on the time of irradiation was measured. The luminescent output was observed to increase rapidly in the first few minutes and then to fall slowly to a saturation level. The variation of the luminescent output with the X-ray intensity for different exposure times was found to be linear. For long exposure times, the slopes of these linear relationships tended towards that exhibited by a specimen which had been additively coloured. The quenching of the luminescence output was much more rapid for potassium chloride than for sodium chloride. Potassium iodide exhibited rapid quenching with no phosphorescence, but potassium bromide gave more stable emission with a long- period phosphorescence. P.J.Dean

20013 APPLICABILITY OF SODIUM SALICYLATE LAYERS AS LUMINESCENT CONVERTERS IN THE NEAR AND FAR U.V. T.Tuchscheerer.

Jenaer Jahrbuch (Germany), 1960 II, 611-44. In German.

Homogeneous layers of sodium salicylate powder were produced with particle size controllable to within ± 25%. The quantum yield for the wavelength range 250-350 × 10^{-7} cm determined to ±5-6% was in good agreement with previous results. The emission spectrum was shown to consist of a single band with character- istics well suited to the blue sensitive barrier layer selenium detector used. For maximum light output an optimum thickness of the fluorescent layer of 0.3 mg cm^{-2} and an optimum powder size of 0.02 mm was found. The dependence of layer thickness on fluorescent and stray light intensities in transmission were in good agreement with calculated results. W.Steckelmacher

20014 FLUORESCENCE CENTRES IN ZnS.

W.Van Gool.

Philips Res. Rep. Suppl. (Netherlands), No. 3, 119 pp. (1961).

This thesis deals with the defect chemistry of ZnS and CdS and the relation of the fluorescence to the lattice defects. A short introduction is given to the preparation technique and the fluores- cence of some well-known phosphor types. The experimental part describes the preparation of some fluorescent and photoconducting materials, devoting particular attention to phosphors containing only coactivators (Al, Cl) and phosphors with equal amounts of activator (Ag, Cu, Au) and coactivator (Al, Sc, Ga, In). The reproducibility of the fluorescence measurements is studied and the temperature dependence of the fluorescence together with the glow curves are reported for some series with increasing concentrations of impurities. The theoretical part starts with calculations about the defect chemistry of ZnS, without and with added impurities, followed by some thermodynamic calculations about the interaction of oxygen with ZnS and CdS. The calculation is separated into three parts: the macroscopic phase diagram, the composition of the atmosphere and the defect chemistry of the sulphides as a function of the variables. The necessary conditions are then formulated to obtained powders with a constant amount of incorporated oxygen and a varying amount of sulphur vacancies, and vice versa. The remaining part of the thesis is devoted to the interpretation of the experimental data with regard to defect chemistry and energy levels. It is shown that, when the amounts of incorporated activator and coactivator are not equal, large numbers of incorporation mechanisms exist. The experimental facts known at this moment are insufficient to make a choice between these possibilities, due to the fact that our present knowledge of such defects as vacancies and interstitials is very scanty. When the concentrations of activator and coactivator are equal more definite conclusions can be drawn. Association effects of the added impurities are interpreted. A model is proposed that can explain at least qualitatively the measured fluorescence, its temperature dependence and the glow curves. Other interpretations, proposed in literature, are discussed. Finally, some indications are given about the further development of the investigations of the fluorescence and defect chemistry of ZnS.

20015

ON THE INTENSIFICATION OF THE LUMINESCENCE BY ELECTRIC FIELDS OF ZINC CADMIUM SULPHIDES ACTIVATED BY MANGANESE.

H.Winkler and H.Röppischer.
Wiss. Z. Hochsch. Elektrotech. Ilmenau (Germany), Vol. 6, No. 2, 113-17 (1960). In German.

A considerable intensification of luminescence under the influence of alternating electric fields was observed in zinc cadmium sulphide activated by manganese and excited by X-rays. Intensification factors from 4 to 7 were measured in the yellow emission range. No field extinction was observed between the wavelengths of 430 and 700 nm. The intensification is voltage and frequency dependent and it is thus assumed that no radiation controlled luminescence has occurred. The material has shown memory effects even in the case of presensitivation by electric field only. E.Erdélyi

20016

FLASHLIKE RISE OF LUMINESCENCE. II. ZnS—Co AND ZnS—Ag,Co PHOSPHORS.

N.A.Tolstoi, A.A.Anufriev, P.G.Deineka, L.A.Rusinov, V.A.Sokolov and A.A.Spartakov.
Optika i Spektrosk (USSR), Vol. 10, No. 2, 177-81 (Feb., 1961). In Russian.

For Pt I see Abstr. 980 of 1958. The properties and rules of the flashlike rise of luminescence of cobalt-activated and silver, cobalt-activated zinc sulphide phosphors are described. The nature of the phenomenon is shown to be connected specifically with the kind of activator present. The experimental results are interpreted from the viewpoint developed in previous papers. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 2, 90-2 (Feb., 1961)].

20017

FLASHLIKE RISE OF LUMINESCENCE. III. EFFECT OF THE INTENSITY OF THE EXCITING AND DEEXCITING LIGHT.

N.A.Tolstoi, A.M.Tkachuk and A.I.Ryskin.
Optika i Spektrosk. (USSR), Vol. 10, No. 2, 220-4 (Feb., 1961). In Russian.

The magnitude and area of the flash in the long wavelength luminescence band are shown to be independent of the intensity of the exciting light owing to identical population of the first trapping levels. Data are presented to show that the form of the rising portion of the short-wavelength luminescence band is affected only by the number of electrons or holes involved in the first trapping. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 2, 110-12 (Feb., 1961)].

20018

ASSOCIATION AND DISSOCIATION OF CENTRES IN LUMINESCENT ZnS—In.

H.Koelmans.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 69-79 (Dec., 1960).

ZnS : In phosphors, which are efficient upon excitation with $\lambda = 3650$ A, were prepared by firing in H_2S at 1200°C and quick cooling to room temperature. The emission spectrum depends on the In concentration and consists of three bands at 6200, 5350 and 4700 A. X-ray analysis shows that the maximum amount of In incorporated is about 10^{-2} g-atôms In per mole ZnS. Refiring the phosphors at 600°C kills the luminescence at room temperature, an effect shown to be due to association. The trivalent In is compe-sated in the lattice by V''_{Zn} (a $\dot{Z}n$ atom vacancy which has captured two electrons). On the basis of the experimental evidence the 6200 A band is ascribed to In_{Zn} (an In atom, with one electron missing, which has replaced a Zn atom), the 5350 A band to the associate $In_{Zn}V'_{Zn}$ and the 4700 A band to V''_{Zn}. The low-temperatu phosphorescence of the ZnS : In phosphors is strongly stimulated b irradiation into bands at 1.8 μ and < 1.2 μ.

THERMOLUMINESCENCE IN ZINC SULPHIDE.

See Aostr. 18917

20019

EFFECT OF PRESSURE ON THE OPTICAL PROPERTIES OF ORGANIC PHOSPHORS.

D.W.Gregg and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 35, No. 5, 1780-8 (Nov., 1961).

The effect of pressure to 54 kbar was measured on absorption spectra, emission spectra, and decay rates of four organic phosphors. For fluorescein and dichlorofluorescein the decay rate increases with increasing pressure. The emission spectrum cons of two peaks which approach each other at high pressure. Thus there appears to be an increased mixing of triplet and excited singlet states at high pressure. For acridine yellow and orange th absorption spectrum shows a dimer and monomer peak. The dime peak decreases rapidly in intensity with increasing pressure. At high concentrations the component decay rates are largely indepen ent of pressure. At lower concentrations the decay rate becomes slower at higher pressure. Evidently the emission can be associat with the dimer.

20020

ABSORPTION AND LUMINESCENCE OF ANTHRACEN IMPURITIES IN 9,10-DIHYDROANTHRACENE CRYSTALS AT 20°K.

V.N.Vatul'ov.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 1, 40-58 (1960). In Ukrainian

Absorption and luminescence spectra of anthracene impurities were obtained in 9,10-dihydroanthracene crystals at 20°K and an electronic vibrational analysis was made. The changes in the spectra with change in the impurity concentration were studied. The author discusses the origin of weak satellites of the electronic transition band. Blue satellites in the absorption spectrum, and lines mirror-symmetrical to them in the luminescence spectra, ar connected with lattice vibrations. Several series are distinguished in the spectra, whose intensity rises with concentration; they are assumed to be due to different impurity centres — deformed and variously incorporated anthracence molecules, pairs of molecules, etc. Among these lines there is the strongly polarized line in the absorption spectrum.

20021

RESPONSE OF ANTHRACENE TO β-RAYS.

I.Řezanka and J.Frána.
Czech. J. Phys., Vol. 10, No. 9, 686-7 (1960).

The scintillation response of an anthracene crystal in vacuum to electrons of energies from 30 to 400 keV was measured. The response versus energy curve is linear with an intercept at 8.5 keV The square of the reduced distribution width is found to be proportional to the electron energy, and yields a value of 2.4 ± 0.2 keV/photo-electron. J.B.Birk

INTERMOLECULAR ENERGY TRANSFER AND CONCENTRATION DEPOLARIZATION OF FLUORESCENCE.

See Abstr. 15886

20022

LUMINESCENCE OF ADSORBED FLUORESCEIN.

E.Lendvay.
Acta. phys. Hungar., Vol. 13, No. 2, 249-52 (1961).

The luminescence spectra of fluorescein adsorbed on Al_2O_3 films, prepared by anodic oxidation and treated with basic solutions were examined. The results indicate that the different emitting centres present are due to different surface OH groups. J.B.Birk

20023

ANOMALOUS PHOSPHORESCENCE OF NAPHTHALEN IN METHYL METHACRYLATE POLYMER.

S.Czarnecki.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 7, 561-3 (1961).

Delayed fluorescence spectra of a 10^{-3} g cm^{-3} rigid solution ere observed at temperatures of 293° and 77°K. The spectra are imilar to the fluorescence spectra. The effect is attributed to ouble excitation of a molecule in the triplet state, by energy ansfer from another triplet-excited molecule, leading to a inglet-excited molecule and an unexcited molecule. The effect was ot observed with similar solutions of α-bromonaphthalene, -iodonaphthalene or phenanthrene. J.B.Birks

20024 DIRECT FLUORESCENCE FROM MONOCRYSTALS OF NAPHTHALENE DOPED WITH ANTHRACENE.

I.Martin-Bouyer and J.Meinnel.
. Phys. Radium (France), Vol. 22, No. 2, 126-8 (Feb., 1961).
French.

The specimens were purified by recrystallization, sublimation nd zone fusion, and single crystals were grown by the Bridgman ethod. The fluorescence spectra, excited by 365 mμ wavelength adiation, and characteristic of the anthracene impurity, were easured for anthracene molar concentrations from 1.6×10^{-4} to $.28 \times 10^{-2}$. The spectra are analysed and compared with published pectral data on anthracene vapour and crystals. As the concentration s increased, the short-wavelength maxima are reduced in intensity nd ultimately suppressed (due to self-absorption). Similar easurements were made using X-ray excitation. No naphthalene luorescence is observed above 4×10^{-4} molar concentration, due o energy transfer. Radiation damage due to γ-rays and neutrons as observed, causing discoloration and changes in the spectra. J.B.Birks

20025 POLARIZATION OF THE LUMINESCENCE FROM MOLECULAR CRYSTALS UNDER β-RAY EXCITATION.

.I.Gribkov, N.D.Zhevandrov and Sh.D.Khan-Magometova.
Optika i Spektrosk. (USSR), Vol. 10, No. 4, 549-50 (April, 1961).
n Russian.

Measurements were made of the dependence of the degree of olarization on the wavelength of the luminescence for a stilbene rystal and an anthracene crystal, under excitation (a) with 313 mμ avelength light, and (b) with β-radiation. Differences in the two modes of excitation occur near the absorption edge, and these are iscussed in terms of the free exciton theory. [English translation n: Optics and Spectrosc. (USA), Vol. 10, No. 4, 285-6 (April, 1961)]. J.B.Birks

20026 FINAL STAGES OF LUMINESCENCE DECAY IN PHOSPHORS WITH LEVELS OF SEVERAL KINDS.

.V.Antonov-Romanovskii.
Optika i Spektrosk. (USSR), Vol. 22, No. 10, 182-7 (Feb., 1961).
n Russian.

A calculation is carried out for the later stages of decay when only the deepest traps of either sign are effective. The calculation is carried out on the assumption that the probability of repeated capture far exceeds the probability of recombination. [English translation in: Optics and Spetrosc. (USA), Vol. 10, No. 2, 92-5 (Feb., 1961)].

20027 THE INFLUENCE OF EXCITATION CONDITIONS ON THE DEAD VOLTAGE OF PHOSPHORS. G.Gergely.

Acta phys. Hungar., Vol. 12, No. 3, 253-5 (1960).

A description is given of the continuation of previously published work on the voltage dependence of the cathodoluminescent brightness, L_V, of thin phosphor layers. These experiments show that the form of the dependence of L_V on the energy of the electrons, and in particular the magnitude of the tail observed in this curve at low voltages (the "dead voltage"), can only be slightly influenced by changes in the conditions of excitation. Attempts to remove this dead voltage by chemical and physical means have also proved unsuccessful. It is concluded that the dead voltage is not due to electrostatic charging of the phosphor layer or to the presence of traps in the phosphor, but that it is a characteristic of the phosphor material. P.J.Dean

20028 SURFACE RECOMBINATION AND DIFFUSION PROCESSES IN CATHODOLUMINESCENCE AND ELECTRON BOMBARDMENT INDUCED CONDUCTIVITY.

G.Gergely.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 112-16 (Dec., 1960).

An analysis of the voltage dependence of cathodoluminescence and electron bombardment induced conductivity is given, taking into account consideration the surface recombination and diffusion processes. The diffusion equation of DeVore is combined with Young's and Feldman's law relating to the penetration and energy loss of incident electrons. A good agreement was obtained between the theoretical and experimental brightness versus voltage curves. By the analysis of this curve the diffusion length L and the surface recombination velocity S may be determined. It was found that $L = 0.05\text{-}0.15\ \mu$ and $S = 5 \times 10^3$ to 5×10^5 cm/sec for several phosphors.

20029 MICROSECOND RESPONSE OF ELECTROLUMINESCENT CELLS. J.E.Johnson.

J. Electrochem. Soc. (USA), Vol. 108, No. 9, 852-5 (Sept., 1961).

Microsecond rise of electroluminescent (EL) output to greater than the steady-state value for a.c. sine-wave excitation was achieved in plastic-embedded powder phosphor cells by application of an a.c. burst having a d.c. component. The decay time for the EL flash, 7 μsec, is considerably longer than the rise time. The EL resulting from a.c. bursts of several voltage waveforms was observed. It was noted that: (a) The EL brightness wave rises in one-half cycle of an a.c. voltage burst when a d.c. component equal to one-half the a.c. peak-to-peak voltage is applied and can exceed the steady-state value, depending on the magnitude of the d.c. pulse. (b) When there is no d.c. component, the EL rises to its equilibrium value in several cycles of the a.c. voltage. (c) The rate of rise of the EL brightness in (b) and the extent of the initial rise in (a) were found to vary with the repetition rate of the a.c. burst. (d) The application of a square wave having the same peak voltage excursions, rather than a sine wave excitation, increases the integrated light-output of the cell. The above were measured, along with the steady-state brightness, at frequencies from 60 c/s to 500 kc/s. From these measurements it is concluded that device applications of EL cells are feasible where fast rise bursts of light are required.

20030 ELECTROLUMINESCENCE IN GALLIUM PHOSPHIDE SINGLE CRYSTALS. S.Iizima and M.Kikuchi.

J. Phys. Soc. Japan, Vol. 16, No. 9, 1784-5 (Sept., 1961).

Metal point contacts on n-type gallium phosphide showed good rectification with reverse breakdown between 5 and 10 V. At breakdown, orange-yellow light was emitted, probably from the point contact. The emission appears to arise from a bimolecular recombination process within the breakdown region. P.J.Dean

20031 THE PROCESS RESPONSIBLE FOR THE VOLTAGE DEPENDENCE OF THE MEAN LUMINESCENCE BRIGHTNESS. A.N.Georgobiani and M.V.Fok.

Optika i Spektrosk. (USSR), Vol. 10, No. 2, 188-93 (Feb., 1961).
In Russian.

Though the main peak of electroluminescent emission probably depends on release of trapped electrons, the voltage dependence of the mean value of the emission was explained as a result of impact ionization. An examination of the probability of this process shows that the observed voltage dependence should occur only in a voltage range below that used. Temperature effects also are not in agreement with the former hypothesis. The experimental data can be explained by the tunnelling of electrons through a barrier, possibly from the valency band of a surface phase of Cu_2S to the conduction band of ZnS. A zone scheme is devised for Cu_2S and ZnS in contact. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 2, 95-7 (Feb., 1961)]. S.T.Henderson

20032 SOME REMARKS ON THE D.C. AND A.C. ELECTROLUMINESCENCE OF ZnS.Cu:Mn.

É.Lendvai, J.Shanda and Ya.Veisburg.
Acta phys. Hungar., Vol. 13, No. 2, 183-92 (1961). In Russian.

Analysing the results of Favorin et al (Abstr. 10081-2 of 1960), the authors come to the conclusion that the alterations observed in the spectrum can be explained by the local heating due to the d.c. component of the a.c.—d.c. electroluminescence appearing simultaneously in the cells and by the thermal quenching effect found in the green light. In the second case the spectra are not voltage- but heat-dependent, the temperature dependences of the bands differing from each other.

20033 THE INFLUENCE OF ADMIXTURES OF ELEMENTS OF GROUP II ON THE THERMOLUMINESCENCE OF SODIUM CHLORIDE CRYSTALS ACTIVATED BY COPPER AND SILVER. J.Dolejší.

Czech. J. Phys., Vol. 11, No. 8, 572-8 (1961). In German.

Single crystals of NaCl with about 10^{-2}% Cu or Ag, some also containing Ca, Sr or Cd to the extent of about 10^{-1}, 10^{-2} or 10^{-2}% respectively, were coloured by exposure to X-rays and their thermoluminescence between 300° and 620°K photographed. A second irradiation and heating followed. For crystals with Cu or Ag only, the second thermoluminescence reproduced the same visible and ultraviolet spectrum with a loss of intensity for most of the bands. The strongest peak was at ~ 3600 A for Cu, 2580 A for Ag. Additions of Ca or Sr increased the intensity of the emission in NaCl NaCl : Cu, especially the 3600 A peak, while Cd caused a general decrease. For NaCl : Ag the 2580 A peak was reduced by Ca whereas the visible peaks increased; Sr gave a general increase and Cd a general decrease. The second cycle showed little change for addition of Ca or Sr to either Cu or Ag, while Cd produced a large decrease in emission. S.T.Henderson

20034
THE THEORY OF THERMOLUMINESCENCE OF IMPURITY CRYSTALS.

Yu.E Perlin, A.E.Marinchuk and A.Z.Kon.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2401-12 (Aug., 1961). In Russian.

Considers the thermoluminescence arising as a result of the radiationless transition of an electron from a metastable localized level to an excited level of a luminescence centre. It is shown that the lifetime of the initial state is determined by this transition. As an example, the probability of radiative tunnelling of F' centres is calculated and a tables shows the rate of decay of the centres for KCl as a function of the distance between the centre and an anion vacancy. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

20035
THERMOLUMINESCENCE IN ANHYDRITE.

W.L.Medlin.

J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 238-52 (Feb., 1961).

The thermoluminescent properties of anhydrite were investigated by duplicating the features observed in natural samples with synthetic preparations. The inclusion of all impurities which are likely to serve as activators and which are commonly found in natural samples was studied by coprecipitating various concentrations of each impurity with high purity $CaSO_4$. It was found that Mn^{2+}, Zn^{2+}, Sb^{3+}, Pb^{2+}, and Cd^{2+} produce characteristic peaks in the glow curves. However, Pb^{2+} and Cd^{2+} do not have appreciable effects except at high concentrations and Sb^{3+} rarely occurs in natural anhydrite. Therefore, only Mn^{2+} and Zn^{2+} are of importance in interpreting the glow curves of most natural samples. The intensity of thermoluminescence as a function of activator concentration was determined for Mn^{2+} and Sb^{3+} but could not be measured over a suitable range for Zn^{2+} because it was impossible to coprecipitate sufficient amounts of this ion. The impurity concentrations were measured by colorimetric procedures. Three of the low-temperature glow peaks observed in natural samples were shown to be associated with anion omissions. It was also demonstrated that all three of the peaks are due to trapping states which belong to a single centre. The suppression of thermoluminescence by such impurities as Fe, Co, Ni, etc., was also investigated. The only case where quenching occurred was for Fe in the presence of Zn^{2+}. This partly accounts for the relatively low emission intensities in natural samples but in general the low intensities are due to the effective exclusion of Mn^{2+}, Zn^{2+}, and Sb^{3+} from the natural crystals.

MAGNETIC PROPERTIES OF SOLIDS

ULTIMATE MAGNETIC SYMMETRY OF PHYSICAL SYSTEMS. See Abstr. 14946

20036
THE CRITICAL TEMPERATURES OF BINARY ALLOYS WITH ONE MAGNETIC COMPONENT.

G.M.Bell and W.M.Fairbairn.

Phil. Mag. (GB), Vol. 6, 907-28 (July, 1961).

Binary alloys with N_A atoms of component A and N_B atoms of component B on $N_A + N_B$ lattice sites are considered. Component A is ferromagnetic or antiferromagnetic with an arbitrary number of Bohr magnetons per atom while B is without magnetic properties. There is a Heisenberg exchange interaction between nearest-neighbour A—A pairs and interaction energies for nearest-neighbour A—B and B—B pairs are introduced. The effect of the local order in the lattice distribution of the A and B atoms on the Curie or Néel temperature is examined both for equilibrium (annealed) alloys where the local order is temperature dependent and for quenched alloys where the lattice distribution is fixed (though not necessarily random). A Bethe-pair (first-order quasi-chemical) statistical approximation is used. It is shown that even though magnetic moments are taken as constant on the A atoms and zero on the B atoms the curves of Curie and Néel temperature against composition vary widely according to the value of the A—B interaction energy and the heat treatment. For quenched alloys there is a critical mole-fraction of A below which there is no spontaneous magnetization; this critical mole-fraction depends on the temperature from which the alloy is quenched. For equilibrium alloys there is also a critical mole-fraction for some values of the A—B interaction parameter but for others a Curie temperature exists for all finite mole-fractions of A. Where A is antiferromagnetic there is always a critical mole-fraction below which no Néel temperature exists but its value varies widely. Some relevant experimental results are discussed.

20037
MAGNETIC COMPOUNDS OF TRANSITION METALS.

T.Nagamiya.

Annu. Rep. Sci. Works Fac. Sci. Osaka Univ. (Japan), Vol. 8, 1-11 (1960).

Following a general introduction, the following topics are discussed: (1) Triangular and screw arrangements of atomic moments. Examples of compounds possessing the former structure are Mn_3O_4, $M_xMn_{1-x}Mn_2O_4$(M = Co, Zn, Mg) $MnFe_{2-t}Cr_tO_4$(t > 0), $NiFe_{2-t}Cr_tO_4$ (t > 1) and $FeCr_2O_4$, $CuCr_2O_4$, and of the latter are MnO_2 and Cr; (2) Weak or parasitic ferromagnetism in NiF_2 and αFe_2O_3; (3) Crystalline distortion due to the Jahn—Teller effect, particularly in trifluorides. S.A.Ahern

20038
MAGNETIC PROPERTIES OF TRANSITION METAL IONS IN ASYMMETRIC LIGAND FIELDS. I. CUBIC FIELD A AND E TERMS.

B.N.Figgis.

Trans Faraday Soc. (GB), Vol. 36, Pt 11, 1553-8 (Nov., 1960).

A semi-quantitative investigation is made of the effect of the removal of the spin degeneracy of those ground terms of transition-metal ions, which are orbitally non-degenerate or two-fold degenerate, on the magnetic moment of the ion. It is concluded that the zero-magnetic-field splitting of the spin levels is sufficient to cause an appreciable dependence of the magnetic moment on temperature in the region of 80°K for $^4A_2$ (most particularly tetrahedral Co^{2+}) and ^5E (most particularly tetrahedral Fe^{2+}) terms. For ^2E and $^6A_1$ terms, no dependence of the moment on temperature is anticipated. With $^3A_1$ (most particularly Ni^{2+}) the effect is likely to be important only at very low temperatures. It is found that the variation of the moment of $HgCo(CNS)_4$ can be well represented by the theory with a reasonable value of the zero-field splitting. The influence of the second-order Zeeman effect with higher ligand-field levels must be taken into account. The zero-field splittings, known and proposed, are compatible with likely values of the asymmetry of the ligand field to which the ion is subject.

20039
MAGNETISM IN TRANSITION METAL ALLOYS.

W.M.Lomer.

Brit. J. appl. Phys., Vol. 12, No. 10, 535-6 (Oct., 1961).

The electronic structure of alloys involving transition elements is complex, but recent studies by various techniques allow the discussion of the range of validity of certain simple concepts. The domain of validity of the idea of a local atomic spin is emphasized and it is pointed out that the collapse of this model is associated with the lifetimes of the spins. When the lifetime becomes very short the model is entirely inappropriate. It appears, however, to apply to the metals Cr, Mn, Fe, Co, Ni and to their alloys with many simple metals.

20040
OBSERVATIONS ON THE OXYGEN SOLUBILITY AND MAGNETIC SUSCEPTIBILITY OF BODY-CENTRED CUBIC TRANSITION METAL ALLOYS.

R.T.Bryant and E.W.Evans

Phil. Mag. (GB), Vol. 6, 805 (June, 1961).

The solubility of O_2 in b.c.c. alloys of Nb with Mo, Rh and Ru was measured and it was found that the solubility fell as the electron-to-atom ratio rose. It is concluded that the O_2 acts in solution as an electron donor. The magnetic susceptibility of Nb as electrons are added by alloying with Mo was found to decrease rapidly with increasing Mo content, with a minimum at about 60 at.% Mo. J.Thewlis

20041 INTERNAL MAGNETIC FIELD IN RARE EARTH METALS. J.Kondo.

J. Phys. Soc. Japan, Vol. 16, No. 9, 1690-1 (Sept., 1961).

The effective magnetic field at the nuclei in rare earth metals is calculated. The contribution from the orbital angular momentum of 4f-electrons was found to amount to several thousand kOe.

20042 THE MAGNETIC INVESTIGATION OF Cu-BUTYRATE MONOHYDRATE AND Cu-STEARATE.

T.Watanabe.

J. Phys. Soc. Japan, Vol. 16, No. 9, 1677-81 (Sept., 1961).

The magnetic susceptibilities of Cu-butyrate monohydrate, Cu-stearate and Cu-acetate monohydrate were measured in the temperature range from 90°K to the room temperature. The energy J of the exchange interaction between the cupric ions Cu^{2+} in the nearest neighbour sites were evaluated from the observed values and the relation $\chi_m = (0.125\ g^2/T)[1 + (1/3)\exp(+J/kT)]^{-1}$. The magnitude of J-values thus obtained were $J_{Cu\text{-}butyrate} = 430^\circ \pm 130^\circ K$, $J_{Cu\text{-}stearate} = 485^\circ \pm 15^\circ K$ and $J_{Cu\text{-}acetate} = 430^\circ \pm 15^\circ K$. And it seems that the g-value for Cu-stearate is somewhat larger than the value for Cu-acetate monohydrate.

PARA–ANTIFERROMAGNETIC TRANSITION IN $MnCl_2.4H_2O$.
See Abstr. 17417

20043 X-RAY AND MAGNETIC STUDIES OF THE MANGANESE–GERMANIUM SYSTEM. T.Ohoyama.

J. Phys. Soc. Japan, Vol. 16, No. 10, 1995-2002 (Oct., 1961).

The constitution of an Mn–Ge system within the range of composition 21.8 ~ 35.7 at.% Ge was examined by X-ray powder diffraction, and the magnetic properties of each phase were studied. The existence of four phases — high and low temperature phases at about 22 ~ 23.5 at.% Ge (ϵ, ϵ_1), a high temperature phase around 28 at.% Ge (ζ), and a low temperature phase at 28.6 at.% Ge (κ) — was established. The κ phase is ferrimagnetic below the Curie point 710°K, and the spontaneous magnetization is reversed at 395°K (N type). The other phases exhibit quite anomalous magnetism. The Debye diagram for ζ phase could be indexed assuming a hexagonal structure with lattice parameters $a = 7.18_6$ A and $c = 13.0_8$ A.

20044 THEORY OF THE MAGNETIC SUSCEPTIBILITY OF HOLES IN GERMANIUM. J.M.Luttinger and P.J.Stiles.

J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 284-91 (Jan., 1961).

A general method of calculation which works for degenerate as well as simple bands is described, and applied to the valence band of Ge. Results are given for both Maxwell-Boltzmann and Fermi-Dirac statistics, and the possibility of comparison with experiments is discussed.

20045 THERMOMAGNETIC STUDY OF THE SYSTEM CoO–NiO. A.Serres.

J. Phys. Radium (France), Vol. 21, No. 6, 551-4 (June, 1960). In French.

The oxides CoO and NiO are miscible in all proportions. A thermomagnetic study of the system CoO–NiO shows that CoO dissolved in NiO exhibits the same behaviour as CoO alone. At high temperatures the variation of χ is represented by the Weiss law: $\chi(T - \theta) = 3.25$. The paramagnetic Curie points θ and the transition points T_c vary almost linearly with the concentration.

20046 MAGNETIC PROPERTIES OF THE POLYCRYSTALLINE ALLOY Cu + 22.8 AT.% Mn.

I.G.Fakidov and B.V.Znamenskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1522-3 (May, 1961). In Russian.

The above alloy is shown experimentally to be antiferromagnetic, over a certain range of low temperatures, when the external magnetic field does not exceed a certain threshold value H_t. The Néel point is 94°K. Below that temperature, and with fields greater than H_t, there is first a transitional stage, in which the state gradually changes to ferromagnetic; H_t depends on the temperature. Above 94°K, for all field strengths, the alloy is paramagnetic, and obeys the Curie–Weiss law. Results are exhibited as two sets of small graphs. [English translation in: Soviet Physics–JETP (USA)].

N.Davy

20047 ADDITIVITY RELATIONSHIPS IN POLAR DIAMAGNETIC SALTS. I. ALKALI AND AMMONIUM SALTS. V.C.G.Trew and S.F.A.Husain.

Trans Faraday Soc. (GB), Vol. 57, Pt 2, 223-35 (Feb., 1961).

The diamagnetic susceptibilities of seventeen alkali and ammonium salts, together with a few other univalent nitrates, were determined by an improved Gouy method in the solid state and in solution. Results are compared with the molar volumes of the salts calculated from measured densities and with molar refraction data. It is confirmed that the systematic relationship between the three properties and the effective atomic number of the cation for related series of salts is a periodic one and not the linear function indicated by the Kido–Ikenmeyer relationship. The effect of change in the co-ordination number of the ions in the crystal is studied and shown to be the determining factor in producing deviations from the regular periodic relationship observed in all three properties for related series of halides and nitrates. A semi-empirical theoretical magnetic susceptibility value for the nitrate ion is calculated by Slater's method (1930) and found in agreement with that obtained from the experimental data. Revised sets of ionic diamagnetic correcting constants for alkali and halide ions are derived from the experimental molar susceptibility of KCl by use of Hartree–Fock self-consistent field data, restricted for crystals in six-fold co-ordination. Values are also calculated by Slater's method for isoelectronic pairs of alkali halides and the various sets of revised constants compared with earlier values.

20048 THE MAGNETIC PROPERTIES OF BERYLLIUM IN THE TEMPERATURE RANGE 300° TO 4.2°K.

B.I.Verkin, I.M.Dmitrenko and I.V.Svechkarev.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 670-1 (Feb., 1961). In Russian.

The angular dependence of χ for Be (above 20°K) and In is found to be described by a cosine law. The temperature dependence of the principal values of χ for Be is characteristic for small groups of electrons. In the case of In, χ is found to be highly sensitive to impurities. [English translation in: Soviet Physics–JETP (USA), Vol. 13, No. 2, 468-9 (Aug., 1961)].

20049 THE MAGNETIC SUSCEPTIBILITY OF SOLID SOLUTIONS OF SEMICONDUCTING COMPOUNDS OF $A^{III}B^{V}$. M.Matyáš.

Czech. J. Phys., Vol. 11, No. 6, 461-3 (1961).

Room temperature measurements of the diamagnetic susceptibility of solid solutions of InSb–GaSb were made by the Gouy method. The results obtained are compared with an equation derived by the author.

R.Parker

20050 MAGNETIC SUSCEPTIBILITY AND GALVANOMAGNETIC EFFECTS IN PURE AND P-TYPE TELLURIUM. G.Fischer and F.T.Hedgcock.

J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 246-53 (Jan., 1961).

The magnetic susceptibility, resistivity and Hall constant of samples of tellurium of various charge carrier densities were measured between 4.2° and 500°K. Pure tellurium shows a temperature independent susceptibility between room temperature and the temperature of liquid helium. All heavily doped samples show a temperature dependent diamagnetism which is though to arise from the free charge carriers. The magnetic susceptibility and galvanomagnetic effects are interpreted with a simple two-band model. Hole effective masses, based on the two-band interpretation of the susceptibility measurements, are found to range from 0.14 to 0.24 m. An impurity scattering effective mass of 0.2 m is found for the holes in the most degenerate sample. Magnetic evidence for the trapping of charge carriers can be seen in the liquid helium region and an estimate of 0.004 eV is obtained for the activation energy of hole formation. All samples show an unexplainable temperature dependent paramagnetic contribution to the susceptibility above room temperature.

20051 ON MAGNETIC AND LUMINESCENT CENTRES INDUCED IN THE CRYSTAL OF LITHIUM FLUORIDE BY X-RAY IRRADIATION. A.Choudhury.

Nuovo Cimento (Italy), Vol. 22, No. 3, 457-61 (Nov. 1, 1961).

The diamagnetic susceptibility of LiF decreases on irradiation with X-rays. The difference in diamagnetic susceptibility of the sample before and after coloration obeys the Curie law. This is due to the paramagnetism of induced colour centres, predominantly

F-centres. On complete thermal bleaching the diamagnetic susceptibility recovers its original value. The changes in magnetic susceptibilities which occur at different stages of thermal bleaching are found to have close correspondence with the integrated intensity of thermoluminescence emission. It is concluded from the results that the destruction of F-centres alone cannot account for the intensity of thermoluminescence emission or magnetic changes.

20052 THE MAGNETIC SUSCEPTIBILITY OF STRYCHNINE.

F.Wagenknecht.

Z. Naturforsch. (Germany), Vol. 16a, No. 6, 635-6 (June, 1961). In German.

Measurements of the gram susceptibility by the Guoy method gave $-0.580 \pm 0.035 \times 10^{-6}$ and $-0.616 \pm 0.022 \times 10^{-6}$ e.m.u. respectively for the basic form and for the hydrochloride-sesquihydrate form of strychnine. There is good agreement between experimental and theoretical values. J.A.Bornmann

DIAMAGNETISM OF A SYSTEM OF INTERACTING PARTICLES. See Abstr. 18300

THE DE HAAS—VAN ALPHEN EFFECT. See Abstr. 17455

DE HAAS—VAN ALPHEN STUDIES OF THE FERMI SURFACE OF MAGNESIUM. See Abstr. 17456

DE HAAS—VAN ALPHEN EFFECT IN Zn AND Cd. See Abstr. 19737

20053 THE TEMPERATURE DEPENDENCE OF THE MAGNITUDE OF THE HYPERFINE SPLITTING OF Dy^{161} LEVELS IN PARAMAGNETIC DYSPROSIUM OXIDE.

V.V.Sklyarevskii, B.N.Samoilov and E.P.Stepanov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 6, 1874-6 (June, 1961). In Russian.

The resonance absorption spectrum of Dy^{161} is investigated in a temperature range extending from 80° to 840°K. γ-rays with energies of 26 or 75 keV from a Gd_2O_3 source, were used in conjunction with a Dy_2O_3 absorber ($\sim$15 mg/cm²), which could be moved to and from the source with uniform velocity. The spectrum was characterized in all cases by a set of five approximately equidistant peaks. The magnitude of the hyperfine splitting is seen to decrease with increasing temperature, and is interpreted on the basis of an electron cloud model. This supposes that the splitting is due to the interaction between the magnetic moment of the Dy^{161} nucleus and the magnetic field, produced at the nucleus by an electron cloud. τ(rel), the spin relaxation time of the electrons, is essentially temperature dependent and this fact is used to explain the temperature dependence of the hyperfine splitting. [English translation in: Soviet Physics—JETP (USA)] M.N.Rudden

MAGNETIC PROPERTIES OF THE URANIUM—NIOBIUM SYSTEM. See Abstr. 17609

20054 PARAMAGNETIC DIFFRACTION OF NEUTRONS BY RARE-EARTH IONS.

S.Odiot and D.Saint-James.

J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 117-37 (Dec., 1960). In French.

By using a method proposed by Trammel (Abstr. 3895 of 1954) the crystalline field effects are taken into account. A means of direct determination is then proposed for the level splittings of the ions. Experiments by Koehler and Wollan (Abstr. 3894 of 1954; 450 of 1959) are discussed, also the validity of the law $I \sim \sin^2\beta$ (where β is the angle between the scattering vector and the magnetic moments) is examined.

20055 THE RELAXATION TIMES OF SOME PARAMAGNETIC DISPERSIONS.

P.H.Fang.

Physica (Netherlands), Vol. 27, No. 7, 681-92 (July, 1961).

The results of Gorter and his collaborators at Leiden on the paramagnetic dispersion of alums is discussed. For some of the results, in order to have a consistent scheme of analysis, it is necessary to extend the analysis of Casimir and Du Pre (1938) by the introduction of new dispersion functions. It is shown that a new dispersion function, previously proposed by the author and others, is in good agreement with most of the experimental data. From this dispersion function the relaxation time is recalculated and is shown to have a different numerical value and a different dependence on mag- netic field and temperature from the old estimation. Some dispersio results which are reported to show a maximum in the relaxation time as a function of field are also discussed. The authors demonstrate the complications in the evaluations of relaxation times from this type of measurement. Without proposing any physical model to explain the nature of the relaxation times they show a consistent mathematical programme of analysing dispersion functions. J.M.Baker

20056 MAGNETIC PROPERTIES OF Co^{2+} IONS IN TETRAHEDRAL INTERSTICES OF AN OXIDE LATTICE.

P.Cossee and A.E.Van Arkel.

J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 1-6 (Aug., 1960).

The magnetic properties of Co^{2+} ions in tetrahedral environment are discussed in relation to published optical data. It appears that the singlet ground state $^4F(\Gamma_2)$ is responsible for a magnetic moment close to the spin-only value, while the $^4F(\Gamma_5)$ level about 4000 cm^{-1} above this singlet gives rise to a temperature-independen paramagnetic term of $\sim 0.5 \times 10^{-3}$ erg G^{-2} mole^{-1}. The expected departure from the Curie—Weiss law is demonstrated by susceptibility measurements on mixed crystals of CoO with ZnO, $CoAl_2O_4$ with $ZnAl_2O_4$ and $CoAl_2O_4$ with $MgAl_2O_4$ between 300° and 1200°K. The magnetic properties of Co^{2+} in tetrahedral interstices are compared with those of Co^{2+} ions in octahedral surroundings.

MAGNETIC AND ELECTRIC PROPERTIES OF CHALCOPYRITE. See Abstr. 19872

20057 THEORY OF DIRECT EXCHANGE IN FERROMAGNETISM.

A.J.Freeman and R.E.Watson.

Phys. Rev. (USA), Vol. 124, No. 5, 1439-54 (Dec. 1, 1961).

An extensive investigation is presented on the role of direct exchange as the mechanism responsible for ferromagnetism. The direct exchange integral J which arises in Heisenberg's theory of ferromagnetism and which has been a subject of considerable speculation and controversy (particularly concerning its sign behaviour as a function of internuclear separation) is considered for several cases for which (as Löwdin has shown) J is rigorously defined. (1) A pair of atoms with a single electron per atom (the hydrogenic case). J is calculated for the unrealistic but historically interesting case of hydrogen 3d functions and the computationally more difficult case of the exchange between 3d orbitals for the iron series elements. The fact that the iron series 3d orbitals are not eigenfunctions of the free atom (hydrogenic) Hamiltonian is shown to affect the results profoundly. Calculations for all pairs of 3d orbitals show that J is sensitive to the angular dependence of the wave-functions (and the precise radial shape as well). (2) A single hole in otherwise closed shells (such as a pair of iron series atoms in the $3d^9$ configuration). The effect on J of "clothing" the atoms with the remaining electrons is discussed first with regard to the effect of the core electrons on the one-electron potentials and secondly with respect to the effect of the overlap of the core electrons. (From an analysis of these terms it is suggested that the paired "4s" conduction electrons of the metal can play an important role in "direct exchange," quite aside from a Zener type of effect). It is found that the direct exchange parameter J is large and negative for the two-electron case [case (1)] and negative, but smaller, for the "clothed" $3d^9$ case [case (2)], whereas for ferromagnetism it should be positive. From this one may conclude that either the direct exchange mechanism is not the dominant source of the ferromagnetism of the transition metals or that the direct exchange model is an inappropriate description of their magnetic behaviour. Finally, a more exact model of direct exchange is discussed, as are some of the problems inherent in carrying it out.

20058 ON THE THEORY OF THE EXCHANGE MODEL OF FERROMAGNETISM.

K.Meyer.

Z. Naturforsch. (Germany), Vol. 16a, No. 6, 631-2 (June, 1961). In German.

In an earlier work (Abstr. 1577 of 1959) transformations were given, by means of which the Hamiltonian for the exchange model of ferromagnetism, with one spin per lattice site, could be expressed in terms of the Hamiltonian for interacting particles obeying Fermi statistics. The method is extended to the case of 2^n-1 spins per lattice site. R.A.Waldron

IRREDUCIBLE REPRESENTATIONS OF THE MAGNETIC GROUPS AND ALLOWANCE FOR MAGNETIC SYMMETRY. See Abstr. 14944

CRITICAL CONCENTRATION OF MAGNETIC ELEMENTS IN RANDOM MAGNETICALLY DILUTE FERROMAGNETIC CRYSTALS. See Abstr. 17385

MAGNETIC PROPERTIES OF IRON, COBALT AND NICKEL. See Abstr. 19914

20059 STATISTICS OF MAGNETIZATION IN THE ISING MODEL. R.L.Stratonovich.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 2955-66 (Oct., 1961). n Russian.

Reports calculations of the magnetization probability distribution in a finite one-dimensional crystal. Magnetization functions are onsidered as a Markov process with a continuous parameter. Dimensions of correlation regions and the spectrum of fluctuations are calculated. [English translation in: Soviet Physics—olid State (USA)].

20060 SOME PROPERTIES OF CONCENTRATED AND DILUTE HEISENBERG MAGNETS WITH GENERAL SPIN.

R.J.Elliott.

J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 165-8 (Nov., 1960).

The constant-coupling approximation is used to obtain the hermodynamic properties of a Heisenberg ferromagnet of general spin above the transition temperature. The variation of these properties with concentration of the magnetic atoms in an alloy are also given. Similar results for antiferromagnets are included in less detail with some critical discussion.

20061 THE BEHAVIOR OF MAGNETIC SYSTEMS WITH DILUTION. J.S.Smart.

J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 169-73 (Nov., 1960).

The Bethe—Peierls—Weiss method is generalized so that it is applicable to alloys and solid solutions. The method is then used o study the effects of magnetic dilution on a classical Heisenberg erromagnet with nearest-neighbour interactions only. The results are qualitatively and quantitatively similar to those obtained by Sato et al. (Abstr. 7150 of 1959) using an Ising model. In particular, he limiting concentration for ferromagnetism is found to be $x_0 = (z-1)^{-1}$, where z is the number of nearest neighbours.

20062 THRESHOLD CONCENTRATION FOR THE EXISTENCE OF FERROMAGNETISM IN DILUTE ALLOYS.

M.Coopersmith and R.Brout.

J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 254-8 (Jan., 1961).

Previous calculations by Brout (Abstr. 674 of 1960), for a magnetically dilute system give a value of $x_0Z = 1$ for the suppression of ferromagnetism, where x_0 is the concentration below which ferromagnetism does not exist and Z is the number of nearest neighbours. Only nearest neighbour exchange forces are assumed to exist. This value was obtained using the first term in the cluster expansion of $1/N \langle \log\langle Z\rangle_R\rangle_C$. Here a more exact expression for x_0Z is found by evaluating the higher order terms in the cluster expansion. It is found that $x_0Z \cong 4/3$ for simple, body-centred and face-centred cubic lattices.

20063 THE SATURATION MAGNETISATION OF THE MONOBORIDES OF Mn, Fe AND Co.

N.Lundquist and H.P.Myers.

Ark. Fys. (Sweden), Vol. 20, Paper 30, 463-71 (1961).

Saturation magnetization measurements were made from −195°C to the Curie temperature of CrB, MnB, CoB, FeB and NiB. Both CrB and NiB show no spontaneous magnetization in the temperature range studied but MnB, FeB and CoB are ferromagnetic possessing respectively the following Curie temperatures measured in an external field of 16 000 Oe: 305, 321 and 204°C. The saturation magnetizations extrapolated to 0°K and infinite field strength are, in the order given above, 163, 93.8 and 22 erg g^{-1} Oe^{-1} corresponding to the following Bohr magneton numbers per transition metal atom: 1.92, 1.12 and 0.28. Certain mixed borides of the form $Mn_xCr_{1-x}B$ and $Mn_xFe_{1-x}B$ and isomorphous with the Mn, Fe and Co borides were also studied. It is found that the Bohr magneton numbers per transition metal atom for MnB, FeB and CoB vary linearly with total electron content of the boride and that the mixed Mn—Fe borides obey the same relationship. Thus in passing from MnB to CoB there is a reduction in moment corresponding to 0.8 μ_B per added electron. On the other hand, the addition of Cr to MnB to form a mixed Cr—Mn boride causes a rapid decrease in magnetization corresponding to 3.4 μ_B per electron. These results are discussed in terms of a two-band model of the kind first proposed by Mott (1935) for the pure transition elements. It is found that the results may be satisfactorily described in terms of this model if the boron atom in these compounds contributes all three $(2p^2 + 3s^1)$ of its outer valence electrons to a common electron-band structure: it is then necessary to assume that only one of the 3d half-bands is unsaturated to account for the properties of those borides lying between MnB and CoB. On the other hand, to interpret the properties of the mixed Cr—Mn borides it is necessary to assume a rapidly developing unsaturation of both 3d half-bands leading eventually to nonferromagnetic behaviour in CrB. A consequence of this interpretation is that CrB should show a strong paramagnetism due to the unfilled 3d band whereas NiB should show a very weak spin paramagnetism since the 3d band in this case should be fully saturated.

20064 ON THE NEW MAGNETIC PHASE IN MANGANESE—ALUMINIUM—COPPER SYSTEM. I.Tsuboya.

J. Phys. Soc. Japan, Vol. 16, No. 10, 1875-80 (Oct., 1961).

It was found that there exists a new ferromagnetic phase in Cu-poor Mn—Al—Cu alloy in the composition range of 25 to 45 at.% Mn, 37.5 to 50 at.% Al and 12.5 to 25 at.% Cu. The crystal structure is CsCl type and the lattice parameter is 2.984 A. This structure is the same as the κ phase in the Mn—Al—Fe system. The magnetic properties may be interpreted in terms of the ferromagnetic structure composed of the Mn atoms which occupy two different sublattices.

20065 REMARKS ON THE MAGNETIC PROPERTIES OF Au—Mn SYSTEM. H.Sato.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 54-60 (April, 1961).

Au—Mn alloys show magnetic behaviour which depends upon the various types of super-lattice existing in this system. The comparison of the magnetic properties of Au_2Mn and Au_4Mn, however, clearly shows a difficulty of interpreting the magnetic structure of Au_2Mn, which is supposed to be helical, from competing positive and negative exchange interactions as often suggested. In both Au_4Mn and Au_2Mn, the Mn atoms form a body-centred tetragonal lattice with c/a ratio of 0.62 and 2.60 respectively. Although the first- and second-neighbour distance between Mn atoms for these two compounds are practically the same, the former is ferromagnetic but the latter is metamagnetic. The first-neighbour distance corresponds to the ferromagnetic interaction range of Mn atoms, but geometrically this alone cannot cause any cooperative alignment of spins. The second-neighbour distance, on the other hand, is too long to expect any appreciable interaction. However, it is proved that the existence of a minor interaction between the second neighbours is sufficient to produce the expected cooperative phenomena. The magnitude of such an interaction is found to be of the same order as the magnetic dipole interaction. Although, at present, it is hard to conclude what kind of interaction is operative, it is suggested that at least the difference of the magnetic behaviour of Au Mn and Au Mn is explained if the magnetic dipole interaction is assumed for the weak interaction.

20066 CRITICAL POINTS AND FERROMAGNETISM. E.P.Wohlfarth and J.F.Cornwell.

Phys. Rev. Letters (USA), Vol. 7, No. 9, 342-3 (Nov. 1, 1961).

The ferromagnetic properties of some Sc—In alloys (Abstr. 12526 of 1961) are ascribed to sharp peaks in the density-of-states curve, such as those given here in illustration for body-centred iron. E.P.Wohlfarth

20067 DETERMINATION OF CURIE TEMPERATURE FROM THE INITIAL SUSCEPTIBILITY.

R.Gerber and K.Závěta.

Czech. J. Phys., Vol. 10, No. 11, 811-19 (1961). In German.

A positive systematic error arises in the determination of the Curie temperature from the turning point of the curve of initial susceptibility versus temperature. The size of the error depends upon the demagnetization factor and the initial susceptibility. An approximation method is presented to minimize the error. J.A.Bornmann

20068 A STUDY OF THE VARIATION WITH TEMPERATURE OF THE SPONTANEOUS MAGNETIZATION OF CHROMIUM TELLURIDE.

L.G.Gaidukov, N.P.Grazhdankina and I.G.Fakidov.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 917-22 (Oct., 1960). In Russian.

The temperature dependence of the spontaneous magnetization of CrTe in the magnetic transformation temperature region was determined by three different methods. The magnetocaloric effect and the magnetization were measured for various magnetic field strengths at various temperatures. The Curie temperature of chromium telluride was found to be + 60° C by the method of thermodynamic coefficients. The results obtained are discussed in terms of the s—d exchange model of ferromagnetism. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 636-9 (April, 1961)].

20069

STUDY OF THE PROCESS OF CHANGING THE AXIS OF EASY MAGNETIZATION OF COBALT.

Y.Barnier, R.Pauthenet and G.Rimet.
C.R. Acad. Sci. (France), Vol. 253, No. 3, 400-2 (July 17, 1961).
In French.

It is shown experimentally that the change of the easy axis of magnetization of cobalt takes place progressively between 518° K and 598° K. At any temperature between these the spontaneous magnetization lies preferentially along a generator of a cone about the C-axis. The magnetization processes have been studied.
A.J.Manuel

20070

THE MAGNETIC PROPERTIES OF ILMENITE—HAEMATITE CRYSTALS. C.M.Carmichael.

Proc. Roy. Soc. A (GB), Vol. 263, 508-30 (Oct. 10, 1961).

The interpretation of both palaeomagnetic and geophysical prospecting data requires a better understanding of the magnetic properties of the iron oxide minerals found in rocks. The magnetic properties of ilmenite—haematite solid solutions were investigated, the unusually large and pure haemo-ilmenite crystals from the Allard Lake region of Quebec being used. The magnetic component of these crystals is an ilmen-haematite phase, having a composition of about 10 mole % of ilmenite in haematite, and present in the form of exsolution lamellae that are roughly 5 μ long, 1 μ wide and 0·2 μ thick. The crystals have a very strong anisotropy causing magnetization in the basal plane and a weak anisotropy which produces an easy direction of magnetization within the basal plane. An improved ilmenite—haematite solvus curve was produced by X-ray and Curie-point analysis of heat-treated crystals. Spontaneous reversal of magnetic polarity takes place with change in temperature in ilmen-haematite having between about 25 and 15% of ilmenite in haematite. This new reversing range of composition is quite different from that found to reverse by Uyeda (1958). The reversal is due to a new antiparallel moment which grows as temperature falls. This was interpreted as being due to an ordering of Fe^{2+} ions on alternate cation layers by an electron transfer mechanism between trivalent and divalent iron atoms.

20071

QUANTUM MECHANICAL DERIVATION OF THE MAGNETIC STRUCTURE OF ANISOTROPIC FERROMAGNETIC SINGLE CRYSTALS. W.Ziętek.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 3, 221-4 (1961). In German.

The anisotropy in the Hamiltonian operator is expressed in terms of multipole coupling terms; domain wall dimensions are estimated.
E.P.Wohlfarth

20072

MAGNETIC ANISOTROPY OF HEUSLER SINGLE CRYSTAL. K.Aoyagi and M.Sugihara.

J. Phys. Soc. Japan, Vol. 16, No. 5, 1027 (May, 1961).

The anisotropy of a single-crystal disk of Cu_2MnAl, whose surface coincided with a (100) plane, was measured as a function of temperature. The anisotropy was found to vary as the fifth power of the magnetization. Measurements of the anisotropy were made as a function of ageing at 110° C from 0 to 1000 hours, but no changes were observed.
P.E.Seiden

20073

ANISOTROPIC MAGNETIZATION.

E.R.Callen and H.B.Callen.
J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 310-28 (Nov., 1960).

In the presence of magnetocrystalline anisotropy the magnetization of a ferromagnet depends upon its orientation as well as upon the temperature. The magnitude and temperature dependence of the anisotropic magnetization, and the conditions under which it should be observable, are discussed. The non-spherical terms are small in iron and nickel, but are appreciable in some uniaxial materials, and large in crystals of low Curie point and large anisotropy. In these materials the magnetization will have a temperature dependence very unlike the Brillouin or spin-wave functions.

20074

ANISOTROPIC CURIE TEMPERATURE.

E.R.Callen.
Phys. Rev. (USA), Vol. 124, No. 5, 1373-9 (Dec. 1, 1961).

In an anisotropic ferromagnet the Curie temperature is a function of the direction of the magnetization. The Curie temperatu is high in easy directions, and can drop quite low in harder directions for an anisotropy energy comparable to the exchange energy. Magnetization curves as a function of temperature also depend upon the orientation. In sufficiently hard directions, the magnetization drops from a large value precipitously to zero at the Curie temperature.

DETECTION OF SHOCK-INDUCED DEMAGNETIZATION IN FERROMAGNETIC MATERIALS. See Abstr. 14937

MAGNETIC COERCIVITY OF A Co—Au ALLOY.
See Abstr. 20603

20075

LINE-WIDTH AND SOME MAGNETIC PROPERTIES OF THE SYSTEM $Ni_{1-x-y}Cu_xCo_yFe_2O_4$. R.Wadas.

Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 5, 241-3 (1960).

Line-width and anisotropy constant measurements give results which are in good agreement with Schlöman's (Conference on Magnetism and Magnetic Materials, Boston, Massachusetts, Oct., 1956, p. 600) theory.
S.A.Aher

20076

ANOMALOUS "DISSYMMETRIC" CYCLES IN THE RAYLEIGH REGION. O.Yamada.

C.R. Acad. Sci. (France), Vol. 253, No. 3, 403-4 (July 17, 1961).
In French.

Displaced hysteresis loops have been observed in the Rayleigh region for a steel specimen, when the cycle was traced at a temperature T_B after demagnetization at a lower temperature T_A.
A.J.Manuel

20077

ANOMALOUS SUSCEPTIBILITY IN THE INITIAL MAGNETIZATION (CURVE) OF A NICKEL WIRE.

O.Yamada.
C.R. Acad. Sci. (France), Vol. 253, No. 4, 629-31 (July 24, 1961).
In French.

The effect of temperature cycling on the susceptibility of a nickel wire in the Rayleigh region of the initial magnetization curve was measured. It was shown that the anomalous increase in the susceptibility was greater for a sample which was measured at temperature T_a, heated to temperature T_b, cooled to T_a and remeasured, than for a sample measured at T_b, cooled to T_a, reheated to T_b and remeasured. This is the exact opposite of the effect observed in steel (Abstr. 16131 of 1960; 1212 of 1961). It is thought that this corresponds with the difference in sign of the magnetostriction constants.
S.A.Aher

20078

FERROMAGNETISM OF THE INTERMETALLIC COMPOUND UFe_2.

S.Komura, N.Kunitomi, Y.Hamaguchi and M.Sakamoto.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1486 (July, 1961).

The specific magnetization as a function of magnetic field strength was determined for UFe_2 at temperatures from 300° to 100° K. This gave a Curie temperature of 195° K, a spontaneous magnetization of 18.0 e.m.u./g at absolute zero and an effective Bohr magneton number of 1.13 per molecule of UFe_2.
J.A.Bornmann

20079

THE APPROACH TO FERROMAGNETIC SATURATION. II. THEORY OF THE APPROACH LAW IN PLASTICALLY DEFORMED FACE-CENTRED CUBIC SINGLE CRYSTALS.

H.Kronmüller and A.Seeger.
J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 93-115 (Feb., 1961).
In German.

For Pt I see Abstr. 11812 of 1960. A quantitative theoretical interpretation is given of recent measurements of the approach to ferromagnetic saturation in nickel and nickel—cobalt alloy single crystals deformed in tension. Using the general theory given in Pt I, the comparison between experiment and theory is based on the dislocation model that was developed elsewhere for the work-hardening in stage II of the stress—strain curve of f.c.c. single crystals. Without adjusting parameters, very good agreement with respect to the absolute magnitude of the differential susceptibility as well as to its dependence on flow—stress, temperature, and agnetic field is obtained. As is discussed in some detail, the agnetic measurements are particularly sensitive to the dislocation rrangement within the piled-up groups and to the long-range stress ields between piled-up groups of opposite sign. A number of refine-ents in the theory of work-hardening are discussed, which, however, ave little effect on the final result. The present results demonstrate at susceptibility measurements provide a quantitative tool for the tudy of dislocation distributions in ferromagnetic materials. In e particular cases studied, they decide the controversy between forest" theories of work-hardening and the "long range stress ield" theory definitely in favour of the latter.

20080 THE PROBLEM OF THE COERCIVE FORCE OF HOMOGENEOUS METALS. C.Schwink.

. Naturforsch. (Germany), Vol. 16a, No. 7, 718-19 (July, 1961).
German.

Discusses qualitatively the coercivity of nickel and cobalt in erms of the energy required to change the domain configuration ssuming rigid Bloch walls. This condition is realized on well-nnealed samples at low temperatures when the magneto-rystalline energy term is so large that the frictional term of the all motion may be neglected. R.Parker

20081 BARKHAUSEN PULSES IN $BaTiO_3$ CONNECTED WITH 90° SWITCHING PROCESSES.

.Březina, J.Fousek and A.Glanc.
zech. J. Phys., Vol. 11, No. 8, 595-601 (1961).

Simultaneous optical and electrical measurements were made o identify 90° switching processes in $BaTiO_3$ crystals, leading to the roduction of Barkhausen pulses. Most of these pulses are caused y the jerky motion of 90° wedge domains; some of the pulses are roduced in the transition of a wedge domain into a domain shaped ike a parallelepiped. Four different possibilities are given for the eneration of Barkhausen pulses on the basis of the probable change n the depolarization and wall energies as a function of the volume f the wedge-shaped and parallelepiped domains: nucleation, jerky rowth of wedge, transition of wedge into parallelepiped and ransition of parallelepiped into a new equilibrium state. Two of hese cases were observed. Photographs show the domain structure n different phases of the process of generation of a Barkhausen ulse.

20082 MAGNETIC ANNEALING EFFECT IN COBALT.

T.Sambongi and T.Mitui.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1478 (July, 1961).

The anisotropy energy induced by annealing in a magnetic field was compared with the measured crystal anisotropy energy K_1 over the temperature range 90°K to 7000°K (Abstr. 10323 of 1954). From the equivalence of these two a mechanism for the origin of the induced anisotropy is proposed (see also following abstract). D.J.Oliver

20083 MAGNETIC ANNEALING OF COBALT.

C.D.Graham, Jr.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1481-2 (July, 1961).

The magnetic annealing anisotropy Ku was measured and compared with the crystal anisotropy energy $K_1 + K_2$ (Abstr. 10323 of 1954). Both curves pass through zero at 300°C and both are nearly linear with temperature. These facts are used to propose a mechanism for the magnetic annealing. D.J.Oliver

20084 THERMOMAGNETIC STUDY OF METALS BY ELECTRON DIFFRACTION. S.Yamaguchi.

Nuovo Cimento (Italy), Vol. 22, No. 3, 487-93 (Nov.,1, 1961).

The temperature of the object bombarded with an electron beam (150 kV, 0.1 mA) was measured by the magnetic method. Invar (Ni: 36%, Fe: 64% by weight) with known Curie point (250°C) and nickel with known saturation induction as a function of temperature served as the reference objects for the experiment. The Lorentz effect observable in the diffraction pattern obtained from the magnetic substance was used for the thermomagnetic analysis. The two temperatures 40° and 300°C were controlled for the objects under the given conditions. Thermomagnetic anisotropy was found in the hexagonal lattice of cobalt. The [110] inductions in this crystal increased about 200 G when its temperature rose from 40° to 300°C at H = 5000 Oe.

THERMO-MAGNETIC ANALYSIS OF INVAR, NICKEL AND COBALT BY AN ELECTRON DIFFRACTION METHOD.

See Abstr. 18973

20085 THE EASY MAGNETIZATION [111] AXIS OF THE Fe_3O_4 CRYSTAL. S.Yamaguchi.

Naturwissenschaften (Germany), Vol. 48, No. 15, 519 (1961).
In German.

Electron diffraction patterns of Fe_3O_4 were recorded in the presence of a magnetic field. Heating by an electron beam allowed a superposition of the patterns at 40° and 300°C. The thermomagnetic splitting of the diffraction spot was observed and it was found that induction was along the [111] axis. It was concluded that the [111] axis is one of easy magnetization. J.A.Bornmann

20086 THEORY OF DOMAIN WALLS IN ORDERED STRUCTURES. I. PROPERTIES AT ABSOLUTE ZERO.

J.W.Cahn and R.Kikuchi.
J. Phys. Chem. Solids (GB), Vol. 20, No. 1-2, 94-109 (June, 1961).

The energy and entropy of domain walls in ordered structures at 0°K are computed as a function of orientation and composition. Structures in which each atom is at a centre of symmetry are treated generally. For these the surface energy, as a function of orientation, has grooved minima for orientations containing bond direction. The surface entropy has cusped minima of zero value for the same orientations. Sharp peaks in surface energy as a function of composition occur at the stoichiometric point, and domain walls in nonstoichiometric crystals have negative surface entropies. Some examples of structures in which some atoms are not at centres of symmetry are given, illustrating the major complications.

20087 THE MAGNETIC FIELD OVER THE SURFACE OF A LAMINAR DOMAIN STRUCTURE WITH BLOCH-WALL-AND SURFACE POLES. C.Greiner.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 6, 328-36 (1960). In German.

A calculation is made of the magnetic field strength as a function of position in a thin film containing domains bounded by Bloch walls normal to the film surfaces and by the surfaces themselves. A numerical example is given for the case of a film containing domains in the form of parallel thin strips, with the film thickness very much greater than the strip width D (measured parallel to the film surfaces). The Bloch wall is taken to be of zero thickness, and results are given for the magnitude and direction of the magnetic field at a height 0.01 D above the lower surface of the film. The field shows peaks at the domain walls. R.A.Waldron

20088 OBSERVATION OF MAGNETIC DOMAIN STRUCTURE DURING MAGNETIZATION IN ALTERNATING FIELDS, AND THEIR RELEVANCE TO REVERSAL LOSSES.

W.Andrä, C.Greiner and W.Schwab.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 9, 539-44 (1960). In German.

The motion of domain walls in Fe—Al and Fe—Si crystals under the action of 50 c/s alternating fields was followed by Bitter pattern investigations. Walls at different parts of the crystals have quite different amplitudes of motion and mobilities, and thus not all the walls participate equally in the reversal processes causing losses. E.P.Wohlfarth

20089 HONEYCOMB DOMAIN STRUCTURE.

J.Kaczér and R.Gemperle.
Czech. J. Phys., Vol. 11, No. 7, 510-22 (1961).

A theory is given of a new structure produced when demagnetizing uniaxial single crystals (e.g. magnetoplumbite) in a field normal to the c axis. The experimental results fully support the theory on the assumption that domain structures produced under normal conditions are metastable. Methods are given by which stable structures can be prepared from such metastable ones. On the basis of these results opinions are expressed as to the nucleation of plate and honeycomb structures, produced either by reducing the field from saturation or by cooling below the Curie point.

20090 MAGNETIC DOMAIN OBSERVATION OF $BaFe_{12}O_{19}$ BY FARADAY EFFECT. H.Kojima and K.Goto.

J. Phys. Soc. Japan, Vol. 16, No. 7, 1483 (July, 1961).

The magnetic domains of $BaFe_{12}O_{19}$ were observed by means of the Faraday effect. Parallel domains were found at high fields and the opening of the hysteresis loop occurred at a critical field of 6000 Oe. Cylindrical domains were found trapped near crystal imperfections. The domain wall, which was parallel to the field, was more stable than the perpendicular wall. J.A.Bornmann

20091 ANTINUCLEATION PROCESSES IN FERROMAGNETICS. A.Jáskiewicz.
Phil. Mag. (GB), Vol. 6, 1057-9 (Aug., 1961).

The critical size for the stability of a domain is shown to depend on the magnitude of the applied field, leading to the disappearance of antiparallel domains in sufficiently high fields. E.P.Wohlfarth

20092 RESONANCE OF DOMAIN WALLS IN COBALT FERRITE.
T.M.Perekalina, A.A.Askochinskii and D.G.Sannikov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 441-7 (Feb., 1961). In Russian.

A resonance dispersion of magnetic permeability due to domain-wall displacement processes is obtained in a monocrystal of cobalt ferrite. Resonance is observed at 360 Mc/s. A comparison is made with the theoretically calculated resonance frequency. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 303-7 (Aug., 1961)].

DOMAIN STRUCTURE OF NICKEL RELATED TO ANOMALOUS ELASTICITY MODULUS. See Abstr. 20304

20093 BLOCH- AND NÉEL-WALLS IN THIN FERROMAGNETIC FILMS. H.D.Dietze and H.Thomas.
Z. Phys. (Germany), Vol. 163, No. 5, 523-34 (1961). In German.

A consistent variational method is developed for the estimation of the energy and structure of domain walls in thin films, and calculations are carried out. K.G.Major

20094 ARRANGEMENT FOR THE PHOTOGRAPHIC RECORDING OF WEISS DOMAINS USING EXPOSURE TIMES OF THE ORDER OF 1 msec. W.Drechsel.
Z. Phys. (Germany), Vol. 164, No. 3, 324-9 (1961). In German.

The magneto-optical Kerr effect was used to give a visible indication of Weiss domains. An evaporated interference layer increased the Kerr rotation and shortened exposure times by several orders. Photographs in the msec range used an electronic flash tube as the light source. This was applied to show changes in the domain structure of an iron single crystal continuing for up to 0.2 sec after de-energizing an electromagnet. W.Steckelmacher

20095 MAGNETIC SHORT RANGE ORDER AND SPECIFIC HEAT IN FERROMAGNETS AND ANTIFERROMAGNETS. J.S.Smart.
J. Phys. Chem. Solids (GB), Vol. 20, No. 1-2, 41-9 (June, 1961).

The Oguchi method is extended to allow for both first and second-nearest interactions. The results are used to calculate the magnetic short-range order parameters and magnetic specific heat above the transition temperature for both ferromagnets and antiferromagnets.

20096 EFFECT OF THE SUBSTRUCTURE UPON MAGNETIC PROPERTIES OF IRON—SILICON SINGLE CRYSTALS.
Y.Nakamura.
J. Phys. Soc. Japan, Vol. 16, No. 10, 1888-92 (Oct., 1961).

The substructure was observed by means of X-ray diffraction microscopy and the magnetic properties were measured at room temperature on single crystals of 4% Si—Fe alloys as produced from the melt at various growth rates. Single crystals produced at slow cooling rate consist of large subgrains with a small orientation difference and have small coercive force and large remanent magnetization, as compared with those produced at fast cooling rate. Such a dependence of magnetic properties upon the substructure is discussed in terms of the nature of sub-boundaries.

SOME PROPERTIES OF $MgO-MnO-Fe_2O_3$ MONOCRYSTALS. See Abstr. 20441

COERCIVE FORCE OF FINE POWDER HEXAGONAL Fe_2C. See Abstr. 20420

20097 THE PROCOPIU EFFECT IN THE CASE OF THIN FILM OF IRON OBTAINED ELECTROLYTICALLY.
V.Tutovan and I.D.Bursuc.
C.R. Acad. Sci. (France), Vol. 253, No. 3, 405-7 (July 17, 1961). In French.

The effect has been studied in films of thickness from 260 mμ to 4.5 μ deposited on copper wires. Currents in the wires giving surface fields up to 25 Oe were used. The effect of compression on a film 2 μ thick was also investigated. A.J.Manue

20098 ON THE THEORY OF MAGNETIZATION REVERSAL OF THIN FILMS. I. NUCLEATION IN HOMOGENEOUS MATERIAL. W.Andrä.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 7, 398-402 (1960). In German.

Reversal of magnetization takes place very often by domain wall motion or by inhomogeneous rotation of the magnetization of a domain. These processes have previously been treated theoretically, on the assumption that domain walls are already present, which may not be the case. The present work examines the process of establishing a wall where none previously existed, by nucleation at the edge of a film. It is shown that for very thin films, homogeneous rotation is the important process in magnetization reversal while for thick films the motion of a wall is considerably impeded. For an intermediate range of thicknesses, the nucleation process is important; once nucleation has set in, wall motion takes place rapidly without hindrance, and hysteresis loops of high squareness ratio are to be expected. R.A.Waldron

20099 RIGOROUS CALCULATION OF THE NUCLEATION FIELD IN A FERROMAGNETIC FILM OR PLATE.
W.F.Brown, Jr.
Phys. Rev. (USA), Vol. 124, No. 5, 1348-53 (Dec. 1, 1961).

The rigorous methods of micromagnetics are used to calculate nucleation fields and corresponding incipient-domain widths for a ferromagnetic film or plate with the applied field along its faces an with a direction of easy magnetization perpendicular to them. The calculation requires finding the largest zero of a fourth-order determinant whose elements depend on the roots of a cubic equation and then maximizing the result by trial-and-error variation of the parameters that determine the period and direction of the sinusoida oscillation in the plane of the film. The calculation was therefore programmed for an electronic digital computer; and to narrow the area of search for zeros, preliminary calculations were done by use of two types of approximation, one of which set an upper and the other a lower limit to the correct zero. The results show that Muller's approximate method of solving the same problem is satisfactory in the range of parameters for which it was designed. Experimental data of Huber and Smith (Abstr. 3058 of 1960) agree satisfactorily with the theory.

20100 STUDY OF THE MAGNETIZATION REVERSAL OF THI COBALT FILMS USING THE MAGNETO-OPTICAL KERR EFFECT. H.Danan, W.Schüppel, W.Andrä and H.Gengnagel.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 10 593-7 (1960). In German.

The magnetization reversal process was studied in thin films o cobalt with induced anisotropy. The domains were rendered visible on the surfaces of the films by the magneto-optical Kerr effect, and a number of photographs are shown. From these, the magnetization was deduced, and a highly rectangular hysteresis loop is shown, agreeing with a loop plotted from fluxmeter measurements. These results are discussed in relation to wall motion and domain rotation It is concluded that the greater part of the magnetization reversal is due to wall motion. R.A.Waldron

20101 ON THE PROBLEM OF THE DEPENDENCE OF UNIAXIAL MAGNETIC ANISOTROPY OF THIN FILMS ON THE ANGLE OF DEPOSITION. M.Ondris and V.Kamberský.
Czech. J. Phys., Vol. 11, No. 6, 454-6 (1961).

The variation with angle of incidence of the uniaxial magnetic anisotropy of Permalloy replicas of obliquely deposited aluminium films is similar to that of obliquely deposited Permalloy films. M.A.Taylo

20102 UNIAXIAL MAGNETIC ANISOTROPY OF THIN NICKEL AND IRON LAYERS DEPOSITED BY CATHODE SPUTTERING. H.Gärtner.
Z. Naturforsch. (Germany), Vol. 16a, No. 8, 841 (Aug., 1961). In German.

A pure iron or nickel rod was arranged as an axial cathode in water cooled Pyrex glass tube. With an axial magnetic field, a ow pressure Penning discharge could be maintained permitting puttering in argon at pressures of about 10^{-3} torr. Magnetization urves of the deposit in two perpendicular directions showed marked anisotropic properties for both nickel and iron films. The anisotropy disappeared after tempering at 450°C for 40 min.

W.Steckelmacher

20103 MAGNETIC ANISOTROPY OF EVAPORATED FILMS. I. IRON FILMS FORMED IN MAGNETIC FIELD.

M.Takahashi, D.Watanabe, T.Sasagawa, T.Kono and S.Ogawa.
J. Phys. Soc. Japan, Vol. 16, No. 10, 1913-23 (Oct., 1961).

The induced magnetic anisotropy of iron films formed on silica substrates by evaporation in a magnetic field was measured by a orque magnetometer. The results obtained are as follows: (1) The xis of easy magnetization does not coincide with the direction of he magnetic field H_d applied during evaporation and the direction f this axis is considerably changed from specimen to specimen; 2) The uniaxial anisotropy constant K_u does not depend on H_d; (3) It is difficult to obtain K_u as a function of the film thickness; (4) K_u decreases with increasing substrate temperature and begins o increase again at about 300° C; (5) K_u tends to vanish after prolonged magnetic annealing; (6) Estimated values of the rotational ysteresis integral range between 1.3 and 2.4 for all films xamined. In order to investigate the origin of the uniaxial anisoropy, several factors are discussed. Directional ordering of mperfections is probable. It may be necessary, however, to onsider the minute structure of evaporated films.

20104 VARIATION OF ANISOTROPY AXIS DISPERSION WITH THICKNESS OF NICKEL—IRON FILMS. H.Clow.

Nature (GB), Vol. 191, 996-7 (Sept. 2, 1961).

The angular dispersion of local anisotropy axes about an verage axis, β, was measured for thin films of 82-18% nickel—ron alloys. It was found that the dispersion increases linearly rom 0.04 radians to 0.52 radians with increase of film thickness n the range of thickness from 120 to 2200 A. The results are iscussed.

S.A.Ahern

20105 THE MAGNETOSTRICTION OF FERROMAGNETIC CRYSTALS BELOW SATURATION.

.R.Birss and E.W.Lee.
Proc. Roy. Soc. A (GB), Vol. 263, 387-94 (Sept. 19, 1961).

The calculations of the magnetostriction of ferromagnetic rystals below saturation by Akulov (1929) and Heisenberg (1931) ave been extended to cover the case of an iron-like single crystal n the form of an oblate spheroid for which the equatorial plane s a (001) crystallographic plane, with the magnetic field applied in ny direction in the equatorial plane. The magnetostriction curves alculated on the basis of Lawton and Stewart's theory of magnetiation curves (Abstr. 1281 of 1948; 4087 of 1949) are compared with measurement of Honda and Masiyama (1926) and of the resent authors. Agreement with the latter is good and such discrepancies as exist can be accounted for satisfactorily.

20106 INITIAL MAGNETIZATION OF NICKEL UNDER TENSION AND HIGH HYDROSTATIC PRESSURE.

R.Gołębiowski and R.Wiśniewski.
cta phys. Polon. (Poland), Vol. 20, No. 5-6, 391-402 (1961).

The interaction of magnetostriction with internal stresses is one of the principal factors influencing the magnetostriction curves of nickel in low magnetic fields. Steinberger (1933) found a 10% increase in the magnetic induction flux density at H = 0.77 Oe and a pressure of 10 000 atmospheres in pure annealed nickel. The present authors attempted to establish to what extent this effect is due to pressure dependence of magnetostriction. For this purpose, the nitial magnetization of nickel both under tension and high hydrostatic pressure was measured.

20107 THE INFLUENCE OF PLASTIC DEFORMATION ON THE MAGNETOSTRICTION CONSTANT OF IRON—NICKEL ALLOYS. P.Šuda and J.Pačes.

Czech. J. Phys., Vol. 11, No. 8, 602-8 (1961).

The magnetostriction constant of three iron—nickel alloys and one Fe—Ni—Co alloy was measured as a function of plastic elongation, up to about 25%. The magnetostriction constant decreases with deformation in all materials. In Fe—Ni—Co alloy the volume magnetostriction also decreases. The influence of crystallographic texture is discussed and it is shown that this is not decisive. The observed decrease is explained by assuming the influence of lattice deformation on spin-orbit interaction.

20108 WEAK FIELD BEHAVIOUR OF THE ΔE EFFECT IN FERROMAGNETIC CUBIC SOLID SOLUTION ALLOYS.

M.Yamamoto and S.Taniguchi.
J. Phys. Soc. Japan, Vol. 16, No. 5, 1035-6 (May, 1961).

In cubic metals and alloys it is sometimes observed that Young's modulus, E, first decreases and then increases with increasing magnetization the ultimate value being greater than in the unmagnetized state. It is suggested that since the decrease is associated with the displacement of non-180° domain walls the negative minimum in ΔE may appear in very weak fields and escape observation. An expression is deduced for the magnitude of the effect for a 90° wall in an ideal simple cubic alloy which it is stated shows good agreement with the results for a 50% Co—Ni alloy; similarly an expression for the dependence of field for the extreme value of ΔE on composition is in accordance with the experimental results. It is concluded that this type of variation is due to the stabilization of domain walls by induced uniaxial ferromagnetic anisotropy.

F.E.Hoare

20109 USE OF A SUSPENSION TENSION TRANSDUCER FOR MEASURING MAGNETOSTRICTION AND HEAT EXPANSION. A.B.Zalesskii.

Pribory i Tekh.Eksper. (USSR), 1958, No. 4, 71-5 (July-Aug.).
In Russian.

The design and operational data are presented of a simple suspension tension transducer for measuring the temperature dependence of magnetostriction. The tension transducer is suitable for studying the thermal expansion of various materials. The sensitivity is such that an absolute elongation of $\sim 2 \times 10^{-7}$ on a 1 mm scale can be achieved, with 5% accuracy for the measurement of magnetostriction. [English translation in: Instrum. exper. Tech. (USA), No. 4, 534-8 (July-Aug., 1958; publ. June, 1959)].

20110 SOME EXPERIMENTAL STUDIES ON THE PARASITIC FERROMAGNETISM OF αFe_2O_3.

A.Tasaki and S.Iida.
J. Phys. Soc. Japan, Vol. 16, No. 9, 1697-1702 (Sept., 1961).

The temperature dependence of magnetization of polycrystalline hematite (αFe_2O_3) which contains several per cent of foreign atoms (Al, Mn, Ga and Cr) was measured at various field strengths. The results were analyzed into the so-called parasitic magnetic moment σ_0 and the susceptibility term χ_g. It was found that the parasitic nature of σ_0 is not influenced severely by the addition of foreign atoms but that the transition temperature is lowered in general and the step transition in the σ_0 versus temperature curve becomes gradual. The residual magnetization was measured with an astatic magnetometer. It was found that the memory effect (in the ratio of the residual magnetization between before and after cooling treatment) is little affected by the addition of foreign atoms or by a change in oxidation. The residual magnetization decreased by about 50% in the first cooling—heating cycle, but was maintained completely in following cycles.

20111 DEVICE FOR ORIENTING AND MARKING FERROMAGNETIC MONOCRYSTAL SPHERES.

A.C.Zalesskii and S.S.Fonton.
Kristallografiya (USSR), Vol. 5, No. 5, 825-7 (Sept.-Oct., 1960).
In Russian.

The device is for locating the principal magnetic axes of ferromagnetic single crystals which are in the form of small spheres. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 789-90 (March-April, 1961)]. I.D.Brown

20112 THE REVERSIBLE TEMPERATURE COEFFICIENT OF REMANENCE OF A Pt—Co PERMANENT MAGNET.

W.L.Zingery and T.M.Wirt.
Canad. J. Phys., Vol. 39, No. 9, 1384-5 (Sept., 1961).

The coefficient was –0.042% (deg C)$^{-1}$. D.J.Oliver

20113 SINTERING OF Ba—Bi FERRITE MAGNET.

M.Sugimoto and T.Takei.
Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, 212-18 (June, 1960).

It is shown that the magnetic properties of a Ba ferrite magnet can be improved to an appreciable degree by addition of Bi oxide or alkaline bithmates and further that such additives reduce the firing temperature in manufacturing. The role of Bi compounds in the Ba ferrite magnet is discussed in connection with chemical and physical processes involved in the preparation of the magnet.

20114 ON THE DECOMPOSITION OF THE FERROMAGNETIC PHASE OF THE HEUSLER ALLOY, Cu_2MnAl.

R.Kimura, T.Ohoyama and K.Endo.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1266-7 (June, 1961).

The isothermal change of electrical resistance shows that the decomposition of the metastable β-phase involves two different mechanisms which show different activation energies at high and low temperatures. C.A.Hogarth

20115 ON ANNEALING EFFECT OF COMMERCIAL SILICON STEEL SHEETS. K.Haga and H.Mizuno.

Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, No. 3, 285-94 (Sept., 1960).

Effects of the final annealing on magnetic properties of transformer steel sheets were investigated. The annealing conditions were varied with the atmosphere, temperature and time, and the specimens used were hot-rolled commercial sheets of T-class containing about 4.5% Si. These sheets were divided into two groups, T-90 to T-105 and T-115 to T-145, from the results obtained by observing permeability at low magnetic field, grain size, content of impurities and mechanical properties, etc.; the former group contain high grade sheets and the latter low grade ones. Annealing of both groups in pure hydrogen gas generally improved the magnetic properties with the increase of annealing temperature; the cause is attributed to the removal of impurities during annealing. In the annealing in closed air, it was found that the permeability at low fields was remarkably increased for high grade sheets only at temperatures in the range of 700° to 850°C, but it was not appreciably increased at higher fields. This fact is very important. Moreover, it was found that such annealing effects depend on the previous treatment of the specimens, as well as the annealing temperature and dimensions of precipitated particles of impurities by annealing. The cause of these effects is discussed.

20116 DISTRIBUTION OF THE DENSITY OF ELECTRONS IN THE 3d-SHELL, WHICH DETERMINE THE FERROMAGNETISM OF NICKEL, COBALT AND IRON.

N.N.Sirota and N.M.Olekhnovich.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 4, 844-6 (Aug. 1, 1961). In Russian.

Since neutrons possess magnetic moments, a neutron beam is scattered not only by nuclei, but also by electrons possessing magnetic moments. If the atomic scattering neutron form factor is first determined from the diffraction lines, then the distribution of the electrons governing ferromagnetism or antiferromagnetism in a lattice can be calculated by the method of summation of three-dimensional Fourier series. This method is applied to iron, nickel and cobalt, and results are given in graphical form. In the special case of nickel the results are compared with values of the electron density calculated from the X-ray atomic scattering form factor. [English translation in: Soviet Physics—Doklady (USA)]. N.Davy

20117 CRITICAL MAGNETIC SCATTERING OF NEUTRONS IN MAGNETITE. T.Riste.

J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 308-17 (Jan., 1961).

The angular distribution of neutrons inelastically scattered from magnetite was analysed for temperatures in the neighbourhood of the Curie temperature. The breakdown of the spin-wave theory in this temperature region reported earlier by Riste et al (Abstr. 8302 of 1959) is discussed. Values of the parameters characterizing the critical fluctuations are deduced from the experiments and compared with theoretical predictions by De Gennes and Villain (Abstr. 11802 of 1960). Some quantitative aspects of the scattering indicate that kinematical braking of the fluctuations, as predicted by the latter authors, may exist. A tentative value of the diffusion constant Λ_1 is derived.

20118 A NEUTRON DIFFRACTION STUDY OF SPIN FLUCTUATIONS IN α-Fe_2O_3. T.Riste and A.Wanic.

J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 318-33 (Jan., 1961).

Diffuse scattering experiments on neutrons in α-Fe_2O_3 reveal the linear dispersion relation for antiferromagnetic spin waves. The spin waves propagate with a velocity of 3.8×10^6 cm sec^{-1}, corresponding to a value of -3.5×10^{-3} eV for the strongest exchange integral. The spin fluctuation scattering in the critical region agrees with calculations based on a local form of molecular field theory.

20119 AN EXAMINATION OF THE SPIN WAVES DISPERSION RELATION IN A FRANKLINITE MONOCRYSTAL BY THE NEUTRON SCATTERING METHOD.

A.Murasik, K.Ruta-Wala and A.Wanic.
Physics (Netherlands), Vol. 27, No. 9, 883-5 (Sept., 1961).

A crystal of $Zn_{0.75}Mn_{0.38}Fe_{1.87}O_4$ was used at liquid air temperature with a neutron beam of wavelength $\lambda = 1.41$ A. Measurements were made of the widths of the magnon peaks for various angles $\theta - \theta_B$ where θ_B is the angle for Bragg reflection for the (111) planes. If for the magnons $\omega = \alpha(h^2q^2/2m_0)$, where $\hbar_q$ is the momentum and m_0 is the mass of the neutron, α was found to be 50 ± 10. D.J.Oliver

20120 POLARIZATION RESULTING FROM THE SCATTERING OF [SLOW] NEUTRONS BY FERROMAGNETIC SUBSTANCES. S.V.Maleev.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1224 et seq. (April, 1961). In Russian.

It is shown that the polarization vector consists of two mutually perpendicular components, one of which is due to the interference of nuclear and magnetic scattering, and the other to inelastic magnetic scattering with spin flip of the neutron. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 860-2 (Oct., 1961)].

20121 A NEUTRON DIFFRACTION STUDY OF THE TEMPERATURE VARIATION OF THE SPONTANEOUS SUBLATTICE MAGNETIZATION OF FERRITES AND THE NÉEL THEORY OF FERRIMAGNETISM. T.Riste and L.Tenzer.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 117-23 (April, 1961).

The neutron diffraction technique is used to study the temperature variation of the sublattice magnetizations of five different ferrites. Qualitative agreement with the Néel theory is obtained in all cases in the respect that the magnetization curve of the tetrahedral ions is more convex than that due to octahedral ions. The data on magnetite are used in a quantitative analysis in terms of molecular field coefficients. It is shown that coefficients determine from conventional magnetic data do not reproduce the sublattice magnetization. This inconsistency is interpreted as an inability of the molecular field equations to take proper account of the magnetic interactions.

20122 THE NATURE OF LOW TEMPERATURE MAGNETIC TRANSFORMATIONS IN FERRITES POSSESSING COMPENSATION POINTS. K.P.Belov.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 692-5 (Sept., 1961). In Russian.

The condition, for which the appearance of a compensation poin of sublattice magnetic moments or of an anomalous temperature variation of spontaneous magnetization in the low-temperature regi should be most probable, is determined by analysing the character of the temperature dependences of spontaneous magnetization in gadolinium ferrite and lithium ferrite—chromite. This condition co sists of the following: one of the magnetic sublattices should posse a "strong" exchange interaction and hence a Weiss spontaneous magnetization temperature dependence, and another sublattice a "weak" exchange interaction which is the cause (in the presence of antiferromagnetic interaction in the "strong" sublattice) of the smeared out temperature dependence of the spontaneous magnetization. It is concluded that in ferrites possessing compensation point low-temperature magnetic anomalies corresponding to a sharp char of the long-range magnetic order in a sublattice with "weak" exchar interaction should be evident. This conclusion is confirmed by experimental data (see also following abstract). [English translation in: Soviet Physics—JETP (USA)].

EFFECT OF QUENCHING TEMPERATURE ON MAGNETIC MOMENT OF FERRITES. See Abstr. 20563

20123 ANOMALIES IN THE PHYSICAL PROPERTIES OF GADOLINIUM FERRITE GARNET IN THE LOW TEMPERATURE REGION. A.V.Ped'ko.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 700-2 (Sept., 1961). In Russian.

The temperature dependences of the magnetic and magnetolastic properties and the ferromagnetic resonance parameters of adolinium ferrite garnet were measured in the low temperature egion. In the neighbourhood of 100°K, the temperature curves of ie initial susceptibility and the paraprocess susceptibility exhibit eaks whereas the coercive force curves and resonance curve widths re minimal. Magnetostriction of the paraprocess and the effect of niform pressure on spontaneous magnetization are maximal at the ame temperature. The results confirm Belov's suggestion (see receding abstract) that low temperature anomalies corresponding o a sharp change in magnetic long-range order in a sublattice with eak exchange interaction should occur in ferrites possessing comensation points. [English translation in: Soviet Physics—JETP USA)].

20124 INVESTIGATION OF THE MEMORY EFFECT IN FERRITES. V.V.Potemkin and Yu.V.Vasil'ev.

okl. Akad. Nauk SSSR, Vol. 140, No. 5, 1051-3 (Oct. 11, 1961).
n Russian.

The memory effect in certain ferromagnetic alloys was first escribed by Williams and Noble in 1950. Here the effect in ferrites s studied and its features described by two sets of graphs. The ffects of the duration of the signal, and various values of the perurbing and constant fields, and of the frequency variation of the erturbing field, are examined. [English translation in: Soviet Physics—Doklady (USA)]. N.Davy

20125 THE EFFECT OF THE DIFFUSION OF ELECTRONS ON THE RADIOFREQUENCY DISPERSION OF THE IAGNETIC PERMEABILITY OF FERRITES WITH THE GARNET YPE OF STRUCTURE.

.A.Smolenskii, Chzhan Tszun [Chang Tsung] and A.K.Stankevich.
iz. tverdogo Tela (USSR), Vol. 3, No. 2, 663-7 (Feb., 1961).
n Russian.

The relation connecting the complex magnetic permeability in eak fields with the frequency, of both polycrystalline specimens nd single crystals of yttrium ferrite with the garnet type of tructure, containing various amounts of Fe^{2+} ions, is investiated experimentally. It is shown that in those cases in which iffusion of electrons occurs, the real part μ^1 of the magnetic usceptibility reaches high values in the low frequency range. he correlation between the magnetic and electric spectra of the errites is discussed. [English translation in: Soviet Physics—olid State (USA), Vol. 3, No. 2, 486-8 (Aug., 1961)]. N.Davy

20126 A NOTE ON THE ELECTRON DIFFUSION AND THE WALL RELAXATION IN FERRITES. H.Sekizawa.

. Phys. Soc. Japan, Vol. 16, No. 5, 1034-5 (May, 1961).

Attention is drawn to the difference in the Richter type peak f magnetic loss in ferrites and ferromagnetic garnet and that due o the loss arising from the diffusion of carbon atoms in iron. The ote attempts to clarify the relation between the motion of the lectrons and the wall relaxation, and to establish the distinction etween the relaxation times involved. F.E.Hoare

20127 MAGNETOCRYSTALLINE ANISOTROPY AND COERCIVITY IN A "SQUARE-LOOP" FERRITE MATERIAL.

.R.Chamberlain.
roc. Phys. Soc. (GB), Vol. 78, Pt 5 (iii), 819-27 (Nov. 15, 1961).

It is shown that the first-order magnetocrystalline anisotropy onstant K_1 of a "sqaure-loop" ferrite material can be determined rom measurements of the approach to saturation of magnetization n a polycrystalline specimen. The energy ($\gamma = 0.20$ erg cm^{-2}) and he thickness ($\delta \cong 1.6 \times 10^{-5}$ cm) of 180° domain boundary walls in commercial manganese magnesium ferrite, Ferroxcube D.1, are stimated from results obtained in this way. The temperature ariation of coercivity in the same material is also discussed in he light of these results, and it is found that the Goodenough theory Abstr. 10344 of 1954) of domain creation is inapplicable. Pores ere observed in the material. Although these have a diameter reater than the estimated domain wall width δ, the experimental esults presented are not consistent with the Néel disperse field heory (1948-9).

20128 A TEMPERATURE DEPENDENT RELAXATION IN A SQUARE LOOP FERRITE. J.R.Chamberlain.

roc. Phys. Soc. (GB), Vol. 78, Pt 5 (ii), 828-30 (Nov. 15, 1961).

Measurements of the initial permeability of a commercial square-loop" ferrite (Ferroxcube D.1) as a function of frequency and temperature are reported. These show the presence of a relaxation, which is due to the damping of domain boundary walls in the material by a process of electron diffusion. It is found that all the domain walls in the material are not affected by this process. The presence of the relaxation does not allow the dynamic characteristics of the domain walls, important in conventional pulsed-reversal experiments, to be determined by the method employed.

20129 DISPERSION OF COMPLEX PERMEABILITY OF LITHIUM FERRITE. F.Voigt.

Ann. Phys. (Germany), Vol. 8, No. 5-6, 278-9 (1961). In German.

The contribution of domain rotation to the permeability was calculated for polycrystalline lithium ferrite. The calculated permeability was less than the experimentally determined value. It was concluded that displacement of the Bloch walls contributes more to the permeability than does the rotation. J.A.Bornmann

20130 ON THE LOW TEMPERATURE-MAGNETIC TRANSFORMATION IN LITHIUM FERRITE—CHROMITES.

A.N.Goryaga and Lin' Chzhan-da [Lin Chang-Ta].
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 3(9), 696-9 (Sept., 1961).
In Russian.

The temperature dependences of spontaneous magnetization, coercive force, magnetic susceptibility and electric resistance were measured for lithium ferrite—chromite compensation points of the sublattice magnetic moments. The anomalies of the temperature dependence of the indicated magnetic and electric characteristics in the low temperature region confirm Belov's suggestion (Abstr. 13830 of 1960) that in ferrites possessing compensation points, low temperature magnetic anomalies should be observed which correspond to a sharp change in the magnetic order in a sublattice with "weak" exchange interaction. [English translation in: Soviet Physics—JETP (USA)].

20131 A REMARK ON THE STRUCTURE OF NON-STOICHIOMETRIC COPPER-MANGANESE FERRITE.

A.Bergstein and R.Gerber.
Czech. J. Phys., Vol. 11, No. 8, 613-16 (1961).

The specific saturation magnetizations of polycrystalline samples of $Cu_{0.875}Mn_{0.302}Fe_{1.823}O_4 \pm\gamma$ were measured by the ballistic method at −196°C. The results, together with the transformation to a cubic spinel structure, are interpreted in terms of the formation of Mn^{2+} and Cu^{2+} in the B lattice sites and progressive transition of the divalent ions into A sites as the number of oxygen vacancies and the annealing temperature is increased. D.G.Holloway

20132 LOW-TEMPERATURE VISCOSITY AND HYSTERESIS OF MANGANESE IRON FERRITES CONTAINING COBALT ADMIXTURES. K.M.Bol'shova and T.A.Elkina.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1299-1301 (May, 1961). In Russian.

The magnetic viscosity losses, magnetostriction and hysteresis properties of a polycrystalline ferrite with the composition $Mn_{1.75}Co_{0.05}Fe_{1.2}O_4$ were studied at low temperatures. A very strong viscosity was detected in static fields up to 250 Oe between −100° and −150°C. The re-magnetization time is of the order of tens of minutes or several hours. It is shown that Perminvar and rectangular loops are formed in the same temperature range in alternating fields. The variation of the loop shape in rising alternating fields is compared with the magnetic viscosity appearing in static fields. [English translation in: Soviet Physics—JETP (USA)].

20133 A REMARK ON THE ANOMALOUS COURSE OF THE RECTANGULARITY COEFFICIENT IN MANGANESE MAGNESIUM FERRITES. J.Brož and J.Šternberk.

Czech. J. Phys., Vol. 11, No. 1, 70-1 (1961).

The value of the nucleation field for reversal of magnetization is studied as a function of temperature for three manganese—magnesium ferrites with different ratios of manganese to magnesium content. From these observations it is deduced that in the main the rectangularity of the hysteresis loop depends on temperature in the way found in an earlier paper (Abstr. 6240 of 1960). There are certain ranges of temperature, however, in which an anomalous effect is observed which is not understood. R.A.Waldron

THE HALL EFFECT IN MONOCRYSTALLINE MANGANESE FERRITES. See Abstr. 17627

SYNTHESIS AND SOME PROPERTIES OF SINGLE CRYSTAL MgAl FERRITES. See Abstr. 20440

20134 MAGNETIC PROPERTIES OF $MgMn_2O_4$.

K.Muramori and S.Miyahara.

J. Phys. Soc. Japan, Vol. 15, No. 10, 1906 (Oct., 1960).

From X-ray measurements it was found that this substance has a tetragonally distorted spinel structure with $c/a = 1.15$. The inverse susceptibility varies linearly with temperature between liquid nitrogen temperature and 550° C, giving for the asymptotic Curie temperature -500° K. This result, and older data, is consistent with a triangular ferrimagnetic model. E.P.Wohlfarth

20135 EFFECT OF POTASSIUM IONS ON FINAL PROPERTIES OF Mn—Zn FERRITE. S.Makolagwa.

Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 9, 543-5 (1960).

The effect on the magnetic properties depends on the conditions under which the ferrite is prepared. The mechanism is discussed. S.A.Ahern

20136 MAGNETIC AFTER EFFECTS IN MANGANESE ZINC FERRITES. T.Akashi and T.Okado.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1641 (Aug., 1961).

The influence of oxygen partial pressure during sintering on Richter-type after-effect and time decrease of initial permeability was measured for MnZn ferrites of varying compositions. It appears that the first effect may be due to $Fe^{2+} \rightleftharpoons Fe^{3+}$ transitions, but it is not clear that this is so for the time decrease of initial permeability. S.A.Ahern

20137 MAGNETIC RELAXATION IN MAGNETITE AND IN ITS SOLID SOLUTIONS WITH MANGANESE AND NICKEL FERRITES. A.Bragiński and T.Merceron.

Nature (GB), Vol. 191, 898-9 (Aug. 26, 1961).

Permeability disaccomodation measurements were made on manganese and nickel ferrites over a temperature range from -250°C to +600°C. Three peaks were observed, attributed to vacancy diffusion. The behaviour of these peaks with varying compositions of the ferrites is discussed, and conclusions are drawn as to the relation between the peaks and the distribution of vacancies. R.A.Waldron

20138 A NOTE ON MAGNETIC AFTER-EFFECT IN IRON RICH FERRITES. S.Krupička.

Czech. J. Phys., Vol. 11, No. 6, 457 (1961).

Disaccommodation $[\Delta(1/\chi)/(1/\chi)]$ measurements were carried out on two samples of iron-rich magnesium ferrites corresponding to compositions $Mg_{0.8}\,Fe_{2.2}\,O_4$ and $Mg_{0.5}\,Fe_{2.5}\,O_{4.02}$. The measurements were made in the temperature range from -200° C to 150° C and both samples show a maximum around 20° C. The results are discussed in relation to those obtained on iron-rich nickel- and manganese ferrites. R.Parker

20139 THE MAGNETIC SPECTRUM OF Ni—Zn FERRITES WITH PERMINVAR LOOPS. F.Voigt.

Naturwissenschaften (Germany), Vol. 48, No. 7, 215-16 (1961). In German.

Measurements were made of the initial permeability, as a function of frequency, of two samples of a nickel—zinc ferrite, one of which had been cooled from a high temperature under the influence of a steady magnetic field, while the other had been cooled in the absence of a magnetic field. Similar measurements were carried out on nickel—zinc ferrites in which a small amount of the nickel and zinc had been replaced by cobalt. The results are related to the relative abilities of domain walls to form with or without the magnetic field during the cooling process. R.A.Waldron

20140 PRODUCTION OF MAGNETIC ANISOTROPY IN FERRITES BY THERMOMECHANICAL TREATMENT.

R.Straubel.

Ann. Phys. (Germany), Vol. 8, No. 7-8, 875-81 (1961). In German.

If nickel ferrite powder is subjected to a plastic tension at elevated temperatures a lowering of magnetic anisotropy results. Conversely, a compression gives rise to an elevation of anisotropy. Torsion balance measurements are reported on nickel ferrites produced in this manner. It is suggested that the anisotropic properties are the result of an alignment of the nonspherical powder particles as a result of the applied stress. This alignment is partially preserved during the sintering process. R.Parker

20141 THE DETERMINATION OF THE MAGNETIC CRYSTAL ANISOTROPY CONSTANT K_1 IN THE SYSTEMS NICKEL FERRITE—MAGNETITE AND MAGNESIUM FERRITE—MAGNETITE

G.Elbinger.

Naturwissenschaften (Germany), Vol. 48, No. 14, 498-9 (1961). In German.

The magnetic anisotropies were determined for compositions varying from $FeO.Fe_2O_3$ to $NiO.Fe_2O_3$ and $MgO.Fe_2O_3$. The determinations were made at temperatures ranging from -185° to +200°C At low temperatures the anisotropy constant became more positive as the magnetite content increased. At higher temperatures the constant reached a maximum at $NiO.FeO(Fe_2O_3)_2$. Because of the low Curie point such a minimum did not appear in the MgO.FeO mixture J.A.Bornmann

20142 PARAMAGNETIC STUDY OF YTTRIUM AND RARE-EARTH FERRITES OF FORMULA $5Fe_2O_3.3M_2O_3$.

R.Aléonard.

J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 167-82 (Aug., 1960). In French.

The paramagnetic susceptibilities of the ferrites of formula $5Fe_2O_3.3M_2O_3$ with garnet structure were measured between the Curie point and 1500° K, for M = Y, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu. The experimental results can be interpreted on the basis of Néel's theory of ferrimagnetism. The curve of the reciprocal susceptibility as a function of temperature is of the third or second degree, for magnetic and non-magnetic M ions, respectively. From these curves, the molecular field coefficients, which are a measure of the interactions between the magnetic ions, can be determined, as well as their temperature coefficient.

20143 MAGNETIC PROPERTIES AND FERRIMAGNETIC RESONANCE IN POLCRYSTALLINE $3Y_2O_3.(5-x)Fe_2O_3.xIn_2O_3$.

Y.Shichijo and T.Miyadai.

Rev. Elect. Commun. Lab. (Japan), Vol. 8, No. 1-2, 12-17 (Jan.-Feb., 1961).

Ferrimagnetic resonance, crystal structure, technical magnetization and the variation of spontaneous magnetization with temperature were studied on polycrystalline, $3Y_2O_3.(5-x)Fe_2O_3.xIn_2O$ with x varying from 0 to 4. The measurements were made at room temperature except for the case of spontaneous magnetization which was measured in the temperature range from -196° to 350° C. Ferrimagnetic resonance line width at 20 000 Mc/s increased rapidly with In content, x ($\Delta H = 130$ Oe at $x = 0$ and 900 Oe at $x = 1.3$) g-factor was almost constant between 2.01 and 2.03 within experimental error. These compounds have a single phase with garnet structure of $O \leq x \leq 1$, but three phases (garnet + $YFeO_3$ + In_2O_3) for $1 < x < 2$ and two phases ($YFeO_3$ + In_2O_3) for $x = 2$, respectively. Spontaneous magnetization at 0° K, σ_0, initially increases with increasing x, while in the range $0.3 < x < 1$ it decreases linearly. Curie temperature T_C decreases linearly with increasing x till $x = 1$ is reached and then becomes constant. With sample having $x > 1$, thermoremanent magnetization was observed and is considered to be due to the $YFeO_3$ phase. For small x, the initial permeability μ_0 increases with x, accompanied by corresponding decrease in coercive force H_C. The greater part of the increase in the line width with x (in the single phase region of x), provided that Schlomann's theory holds, appears to be intrinsic.

20144 ON THE PROPERTIES OF MIXED YTTRIUM DYSPROSIUM GARNETS.

A.Vassiliev, J.Nicolas and M.Hildebrandt.

C.R. Acad. Sci. (France), Vol. 252, No. 18, 2681-3 (May 3, 1961). In French.

The saturation moments of substances corresponding to the formula $3[(1-x)Y_2O_3, xDy_2O_3], 5Fe_2O_3$ were measured as a function of temperature. The Curie and compensation points were deduced. The effective gyromagnetic factors, and resonance line width were measured at 9539 Mc/s. A.J.Manuel

20145 ANOMALIES IN THE TEMPERATURE DEPENDENCE OF THE COERCIVE FORCE IN RARE EARTH ELEMEN GARNET FERRITES IN THE NEIGHBOURHOOD OF THE COMPENSATION POINT. K.P.Belov and A.V.Ped'ko.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No.4(10), 961-4 (Oct., 1960). In Russian.

Anomalous maxima of the coercive force were found in the region of the compensation point. In the polycrystalline ferrites the height and breadth of these maxima depend on the specimen density and, in addition, a doubling of the peaks is observed. There are also anomalous maxima in single-crystal specimens, but they are narrower than in polycrystalline specimens. A qualitative explanation of the observed phenomena is given. It is suggested that the strong broadening of the ferromagnetic resonance absorption lines in ferrites, previously observed, on approaching the compensation point is due to a cause related to that underlying the anomalous increase in coercive force near this point. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 666-8 (April, 1961)].

20146 HIGH FIELD MAGNETIZATION STUDY OF FERRIMAGNETIC ARRANGEMENTS IN CHROMITE SPINELS.

I.S.Jacobs.

J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 54-65 (Aug., 1960).

The observation of a differential susceptibility at high magnetic fields and low temperatures in spinel-type compounds has been shown to be useful for detecting non-collinear ferrimagnetic arrangements. Such an increase in net magnetization with field is not expected for the Néel model of tetrahedral A-site moments antiparallel to octahedral B-site moments. It is, however, expected for the triangular arrangements proposed by Yafet and Kittel (Abstr. 7388 of 1952) in which the moments on one kind of site subdivide into two groups making angles with each other. The latter arrangements have frequently been suggested for chromium-containing spinels, usually on the basis of the observed anomalously low spontaneous magnetizations. Measurements of magnetization curves at 4.2°K in pulsed fields up to 140 kOe reveal high field susceptibilities in $MnFe_{2-t}Cr_tO_4$, $t > 0$, $CuCr_2O_4$; $FeCr_2O_4$; and $NiFe_{2-t}Cr_tO_4$, $t > 1$. These are interpreted as triangular ferrimagnetic arrangements and choices are made between alternative triangular models. In some cases the sign of the dominant anisotropy is suggested. Néel antiparallel ferrimagnetic arrays are confirmed for $MnFe_2O_4$ and for $NiFe_{2-t}Cr_tO_4$, $t < 1$. The present evidence for these conclusions is of a new and occasionally more direct type. [A summary of this work appeared in Abstr. 11901 of 1960].

20147 INFLUENCE OF THE BOUNDARY SURFACE OF THE CRYSTAL LATTICE ON THE SPIN-WAVE RESONANCE IN A FERRIMAGNETIC MEDIUM. A.R.Ferchmin.

Acta phys. Polon. (Poland), Vol. 19, No. 4, 487-97 (1960).
In German.

The spin-wave resonance caused by the homogeneous magnetic exchange field in a thin ferrimagnetic specimen is studied. A solution is obtained of N semi-classical spin-wave equations. The form of these solutions depends on whether the spin moments at the two ends of a ferrimagnetic chain are equal or opposite. It is shown that, as well as the usual spin waves with periodic amplitude, aperiodic spin waves can also be set up. R.A.Waldron

20148 ON THE HIGH TEMPERATURE SUSCEPTIBILITY OF FERRIMAGNETICS AND ANTIFERRIMAGNETICS.

B.Fechner.

Acta. phys. Polon. (Poland), Vol. 20, No. 1, 89-91 (1961).

Expansions are obtained for χ in powers of T^{-1} and for χ^{-1} in powers of T^{-1} using the method of Rushbrooke and Wood (Abstr. 13423 of 1959). D.J.Oliver

20149 THE NEW MAGNETIC PHASE IN MANGANESE—ALUMINUM—NICKEL SYSTEM.

I.Tsuboya and M.Sugihara.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1257 (June, 1961).

A ferrimagnetic phase was observed in Mn—Al—Ni which is the same as the κ-phase observed in Mn—Al—Cu and Mn—Al—Fe. The composition range of this material was found and the lattice parameter, Curie temperature and susceptibility were measured and found to be strongly composition dependent. P.E.Seiden

20150 MAGNETIC PROPERTIES OF B8 TYPE COMPOUNDS IN MANGANESE—TIN SYSTEM. M.Asanuma.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1265-6 (June, 1961).

Saturation magnetization, Curie temperature and lattice constants for $Mn_{1+x}Sn$, $x = 0.5, 0.6, 0.7, 0.8$, were determined. Saturation magnetization at 0°K decreases as Mn content increases and suggests the occurrence of ferrimagnetism. Depending on the lattice site occupied the moment of the Mn atom is 2.2 or 3.5 μ_B. The results are discussed in relation to Guillaud's suggestion regarding critical distance for ferromagnetic and antiferromagnetic interaction between Mn atoms. F.E.Hoare

20151 ANTIFERROMAGNETIC CHAIN.

H.Falk and T.W.Ruijgrok.

Physica (Netherlands), Vol. 27, No. 7, 710-16 (July, 1961).

For a chain of N atoms of spin $\frac{1}{2}$ with nearest-neighbour Heisenberg exchange coupling, the Hamiltonian is linearized and the resulting model is solved exactly. The qualitative thermodynamic behaviour is established for the model, which exhibits a long-range order and is shown to undergo a phase transition at a critical temperature T_c.

20152 CRITICAL CURVES OF AN ANTIFERROMAGNETIC ON THE ISING MODEL FOR LOOSE PACKED LATTICES.

D.M.Burley.

Physica (Netherlands), Vol. 27, No. 8, 768-76 (Aug., 1961).

It is shown that, for the simple quadratic and simple cubic lattices, an extension of the method of Kikuchi gives an approximate treatment of an antiferromagnet on the Ising model. It is found that the solution of the resulting equations reduces to the numerical solution of a single polynomial equation. The critical curves dividing the antiferromagnetic and paramagnetic regions are obtained and compared with other approximations and models.

20153 MODIFIED DERIVATION OF THE DISPERSION LAW FOR LONG SPIN WAVES IN ANTIFERROMAGNETIC REGULAR SUPERSTRUCTURES. H.Cafta.

Acta. phys. Polon. (Poland), Vol. 20, No. 2, 181-3 (1961).

Gives a direct derivation of the approximate dispersion formula valid for small values of the propagation vector. The formula derived is said to be useful for studying the properties of spin waves in regular antiferromagnetic superstructures.
D.J.Oliver

20154 CONDITIONS FOR THE EXISTENCE OF A FEEBLE FERROMAGNETISM IN ANTIFERROMAGNETICS.

E.Tourov.

C.R. Acad. Sci. (France), Vol. 252, No. 22, 3420-2 (May 29, 1961).
In French.

A theoretical discussion of the symmetry conditions under which feeble ferromagnetism can arise in an antiferromagnetic structure.
D.J.Oliver

20155 SUPERPARAMAGNETISM OF FINE PARTICLE ANTIFERROMAGNETICS. L.Néel.

C.R. Acad. Sci. (France), Vol. 252, No. 26, 4075-80 (June 26, 1961).
In French.

It is shown that fine particles of an antiferromagnetic substance (Size 100A or less) will in general exhibit a superparamagnetism due to the incomplete compensation of moments of the two sublattices. The susceptibility of this state can surpass the normal antiferromagnetic susceptibility. D.J.Oliver

20156 SUPERANTIFERROMAGNETISM IN FINE GRAINS.

L.Néel.

C.R. Acad. Sci. (France), Vol. 253, No. 2, 203-8 (July 10, 1961).
In French.

It is shown that antiferromagnetics in the form of fine grains possess an increased susceptibility in the ordered region which is of the same order of magnitude as the normal susceptibility and which is connected with a progressive rotation of the direction of antiferromagnetic alignment from one extremity of the grain to the other. The magnetic field region over which this increase extends is greater the smaller the dimensions of the grain. S.A.Ahern

20157 CALCULATION OF THE ADDITIONAL SUPERANTIFERROMAGNETIC SUSCEPTIBILITY OF FINE GRAINS, AND ITS TEMPERATURE DEPENDENCE. L.Néel.

C.R. Acad. Sci. (France), Vol. 253, No. 13, 1286-91 (Sept. 25, 1961).
In French.

20158 SCATTERING OF SLOW NEUTRONS IN ANTIFERROMAGNETICS. V.A.Popov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2589-603 (Sept., 1961).
In Russian.

Deals with elastic and inelastic (one-magnon) scattering of slow neutrons in a uniaxial antiferromagnetic placed in a magnetic field. [English translation in: Soviet Physics—Solid State (USA)].

20159 NEUTRON DIFFRACTION INVESTIGATION OF ANTIFERROMAGNETISM IN $CrCl_3$.

J.W.Cable, M.K.Wilkinson and E.O.Wollan.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 29-34 (April, 1961).

Neutron diffraction observations were made on powder and single crystal samples of anhydrous $CrCl_3$ at temperatures from 298 to 4.2°K. This hexagonal layer-type crystal undergoes a transition at 16.8°K to an antiferromagnetic state in which the magnetic moments within each hexagonal layer of metal ions are aligned parallel but adjacent layers of moments are oppositely directed. The axis of spontaneous sublattice magnetization is closely perpendicular to the c-axis. Observations of the (003) antiferromagnetic reflection in an external magnetic field show that the antiferromagnetism can be destroyed with fields of only a few kilo-oersteds, and lead to the conclusion that a net magnetization can be produced with very small magnetic fields.

20160 MAGNETOELECTRIC EFFECT IN CHROMIUM OXIDE.

D.N.Astrov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1035-41 (April, 1961). In Russian.

The magnetization produced by an electric field in a Cr_2O_3 single crystal was investigated. The magnetization is proportional to the field, as predicted by theory. The proportionality coefficient was measured to be 4.3×10^{-4} at 20°C. The magnetic moment along the threefold axis and the magnetic moment in the basal plane have opposite signs in the temperature range from 310° to 80°K. Near the transition temperature, the magnetic moment in the basal plane is well fitted by $\alpha_\perp \propto (T_N - T)^{1/2}$, in agreement with the theory of second-order phase transitions. The temperature dependence of the magnetic moment along the threefold axis is very complicated. Possible causes of the observed temperature dependence are discussed. A connection is established between the sign of the magnetic moment and the magnetic structure. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 729-33 (Oct., 1961)].

20161 HEAT TREATMENT AND THERMOREMANENT MAGNETIZATION OF THE ANTIFERROMAGNETIC COMPOUND $Cr_{100}Sb_{94}$.

R.Wendling.

C.R. Acad. Sci. (France), Vol. 252, No. 22, 3423-5 (May 29, 1961). In French.

Specimens were quenched from 1080° C and then subjected to various heat treatments. The resulting magnetic properties are described. D.J.Oliver

20162 ANTIFERROMAGNETISM IN ALLOYS OF GOLD AND CHROMIUM.

E.Wachtel and U.Vetter.

Naturwissenschaften (Germany), Vol. 48, No. 6, 156-7 (1961). In German.

Alloys of up to 13 atom % chromium in gold were found to be paramagnetic and to obey the Curie—Weiss law. For alloys with a chromium content greater than 13 atom % there is a Néel point which depends upon the concentration. The annealing and quenching techniques alter the position of the Néel point and the shape of the susceptibility versus temperature curve. J.A.Bornmann

20163 SUBLATTICE SWITCHING IN ANTIFERROMAGNETS.

W.J.O'Sullivan, W.A.Robinson and W.W.Simmons.

Phys. Rev. (USA), Vol. 124, No. 5, 1317-18 (Dec. 1, 1961).

An experiment is described which enables an antiferromagnetic sublattice assignment to be monitored in the presence of a small applied magnetic field. Using this technique it becomes possible to observe sublattice switching events, should they occur. It is concluded, despite the negative character of the results, that a particular magnetic sublattice assignment in $CuCl_2.2H_2O$ can be considered a stable form at 1.4°K.

20164 MAGNETIC ANISOTROPY OF $KCoF_3$ AND $KNiF_3$.

K.Hirakawa, T.Hashimoto and K.Hirakawa.

J. Phys. Soc. Japan, Vol. 16, No. 10, 1934-9 (Oct., 1961).

Magnetic anisotropy of single crystals of $KCoF_3$ and $KNiF_3$ was investigated by the torque magnetometer in the temperature range from 78° to 300° K. In the antiferromagnetic region, torque curves of these crystals when suspended along one of the cube edges can be expressed by the formula $T = C_1H^2 \sin 2\theta - C_2H^4 \sin 4\theta$, where H is the magnetic field intensity, θ the angle of rotation of H relative to one of the cubic axes, and C_1 and C_2 are constants. In the case of $KCoF_3$ the 4θ term was not observed, while in $KNiF_3$ the 4θ term was dominant in all specimens when no external stress was applied. The amplitude of the 2θ term is sensitive to the stress in both cases. The experimental results on $KCoF_3$ and $KNiF_3$ are well interpreted by taking the antiferromagnetic spin axis to be parallel to the c-axis below their Néel temperatures. The origin of the 4θ term which was observed in $KNiF_3$ is discussed, and it is concluded that this term arises from reversible movements of the antiferromagnetic domain walls existing in this compound.

20165 NUCLEAR RESONANCE STUDIES OF ANTIFERROMAGNETIC $LiCuCl_3.2H_2O$.

R.D.Spence and C.R.K.Murty.

Physica (Netherlands), Vol. 27, No. 9, 850-6 (Sept., 1961).

The Li^7 and proton nuclear magnetic resonance in $LiCuCl_3.2H_2O$ shows this compound to be antiferromagnetic with a Néel temperature of 4.46 ± 0.02° K. The local fields at the Li and proton sites combined with the quadrupole splitting of the Li resonance and the dipole—dipole splitting of the proton resonance indicate that the magnetic symmetry group of this crystal must be one of three possible types.

20166 ANTIFERROMAGNETISM OF MnHg.

Y.Nakagawa and T.Hori.

J. Phys. Soc. Japan, Vol. 16, No. 7, 1470 (July, 1961).

The magnetic susceptibility, electrical resistivity, and lattice constant of MnHg were measured as a function of temperature between 90 and 360°K. The Néel point is found to be 198°K from the maximum in the susceptibility and an anomaly in the electrical resistivity. However, the susceptibility above 198°K does not fit a Curie—Weiss law. No cubic to tetragonal transition was observed in contrast to the similar MnAu and MnPd. P.E.Seiden

CRYSTAL STRUCTURE DISTORTIONS IN MnO_2 AND MnF_2 AT THEIR ANTIFERROMAGNETIC CURIE TEMPERATURE.

See Abstr. 20545

20167 MAGNETIC PROPERTIES OF THE $\beta_2^{(1)}$ PHASE OF THE COMPOUND $Mn_{38}Pd_{62}$.

R.Wendling.

C.R. Acad. Sci. (France), Vol. 253, No. 3, 408-10 (July 17, 1961). In French.

When quenched from 1200° C this compound shows antiferromagnetic behaviour with a sharp maximum in the susceptibility at 220° C. On then heating to 450° C the susceptibilities at different temperatures increase and become strongly field dependent. In a high field a remanent anisotropy of the susceptibility is introduced. A.J.Manuel

20168 THE MAGNETIC SUSCEPTIBILITY OF MANGANESE ZINC FLUORIDE SOLID SOLUTIONS.

D.M.Finlayson, I.S.Robertson, T.Smith and R.W.H.Stevenson.

Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 318-20 (Aug., 1961).

Measurements of susceptibility were made to very low temperatures (~ 4°K). In the higher temperature region ($T > 30°K$) $\chi = Cm\ (T + \Delta)^{-1}$ with Δ decreasing with dilution of the magnetic ion. For the most dilute sample ($Mn_{0.11}\ Zn_{0.89}\ F_2$) there is no departure from the simple law but for $Mn_{0.87}\ Zn_{0.13}\ F_2$ the χ^{-1} versus T curve exhibits a minimum which is also found in MnF_2. It is concluded that susceptibility measurements below the Néel temperature are a useful test of antiferromagnetic ordering. D.J.Oliver

20169 THE MAGNETIC PROPERTIES OF $NiBr_2$.

I.Tsubokawa.

J. Phys. Soc. Japan, Vol. 15, No. 11, 2109 (Nov., 1960).

Measurements of magnetic susceptibility between liquid He and room temperature show a sharp maximum near 60°K. This is assumed to be a Néel point for antiferromagnetism. Above this temperature the susceptibility follows a Curie—Weiss law with a paramagnetic Curie temperature $\theta_p = -20°K$. A.J.Manuel

ANTIFERROMAGNETIC PROPERTIES OF VIVIANITE.

See Abstr. 20269

20170 CONCERNING THE QUANTUM THEORY OF ANTIFERRIMAGNETICS.

L.Kowalewski.

Acta phys. Polon. (Poland), Vol. 20, No. 7, 545-51 (1961). In German.

The dispersion formula for a ferrite with an inverse spinel structure was calculated by means of the Holstein Primakoff method (Abstr. 288 of 1941). Anisotropy arises because of the magnetic superstructure. In the case of equally large spins in an octahedral lattice E is proportional to K^2. The results agree with previous derivations if proper corrections are made. J.A.Bornmann

20171 ON THE DISPERSION FORMULA IN FERRITES WITH SPINEL STRUCTURE.

L.Kowalewski.

Acta. phys. Polon. (Poland), Vol. 20, No. 8, 675-8 (1961).

Discusses the errors in papers of Vonsovskii and Seidov [Izv. Akad. Nauk SSSR, Ser. fiz. (USSR), Vol. 18, 319 (1954)] and Kaplan (Abstr. 1767 of 1958), and refers back to the author's earlier work (see preceding abstract).

Magnetic Resonances

THE PROPERTIES OF SEMICONDUCTORS WITH EXTREMAL LOOPS. See Abstr. 19842

20172 THE INFLUENCE OF DEMAGNETIZATION, ANISOTROPY AND STRESS ON THE RESONANCE CONDITION OF SPIN-WAVE RESONANCE. D.Fraitová.
Czech. J. Phys., Vol. 11, No. 7, 500-9 (1961).

Spin-wave resonance equations of motion, based on Valenta's model of a thin film (Abstr. 8303-4 of 1959), are derived on the basis of quantum mechanics. The Hamiltonian including Zeeman, exchange and dipolar interaction is considered first. Phenomenological terms respecting the influence of anisotropy and stress are introduced into the equations of motion and the resonance condition is derived. The influence of the above effects on the resonance condition is discussed and a comparison is made with experiment.

20173 THEORY OF FERROMAGNETIC RESONANCE LINE SHAPE IN INSULATORS. J.Loos.
Czech. J. Phys., Vol. 10, No. 11, 775-81 (1960).

The paper discusses the absorption of the energy of a high-frequency field by a magnetic sample from the point of view of the interaction of spin waves with photons and spin waves amongst themselves. A general expression for the form of the absorption curve is derived, using the method known from the quantum theory of radiation and assuming very weak fields.

20174 INFLUENCE OF INHOMOGENEITIES IN MAGNETIC CRYSTAL ON FERROMAGNETIC RESONANCE LINE SHAPE. J.Loos.
Czech. J. Phys., Vol. 10, No. 12, 887-901 (1960).

The general theory of the preceding paper (see preceding abstract), is applied to a concrete case. The spin wave interaction operator H^S is derived by quantizing a phenomenological expression, which expresses the contribution to the energy of the magnetic sample, caused by fluctuations in the anisotropic and exchange interaction. The influence of thermally excited spin waves on the absorption of energy from a high-frequency field and the justification for the application of the general results of the preceding paper are discussed on the basis of the form of the operator H^S. The interaction operator of the magnetic sample with the h.f. field is also determined, and it is used to give a definite form to the expression for the resonance curve of the imaginary part of the susceptibility χ''. Using the matrix elements of the operator H^S the quantity α, which formally corresponds to the width of the resonance χ''-curve, is calculated. The magnitude of α is estimated numerically and the results are compared with those obtained by Clogston et al. and by Schlömann for the line width in monocrystals and the shape of the resonance curve in polycrystals respectively. The expression obtained on the basis of the theory of the preceding paper for the frequency shift diverges in this case. The way in which to avoid this divergence is indicated.

BROADENING OF FERROMAGNETIC RESONANCE ABSORPTION LINE IN FERRITES. See Abstr. 20182

20175 A CONTRIBUTION TO THE THEORY OF FERROMAGNETIC RESONANCE AT HIGH POWER LEVELS. J.Loos.
Czech. J. Phys., Vol. 11, No. 7, 490-9 (1961).

The instability of spin waves at ferromagnetic resonance is discussed. An equation of the stationary state of spin waves $k \neq 0$ is derived by means of the quantum theory of spin waves. It is shown when discussing this equation that the concept of the critical uniform precession angle may be obtained when using an approximation which neglects the action of spin waves $k \neq 0$ backward on their own excitation. It is thought that, due to this effect, a stable stationary state can exist even above the critical amplitude of uniform precession, given by previous theories.

20176 FERROMAGNETIC RESONANCE ON COBALT WHISKERS. Z.Frait.
Czech. J. Phys., Vol. 10, No. 7, 546-7 (1960).

Experiments were carried out at a wavelength of 3 cm and with external fields up to 2900 Oe. The width of the line depends on crystal perfection, surface quality and the angle between the crystal axis and the axis of the whisker. The line width varied from 75 to 10^3 Oe whilst the intensity was very sensitive to surface imperfections. The line observed was a doublet and this is tentatively explained by the existence of a domain structure. D.J.Oliver

20177 FERROMAGNETIC RESONANCE IN THIN COBALT FILMS. Z.Frait.
Czech. J. Phys., Vol. 11, No. 5, 360-8 (1961).

The paper gives the results of measuring ferromagnetic resonance on thin cobalt films, vacuum deposited on unheated glass slides. The values of the g-factor, the width of the curve, the effective stress and uniaxial induced anisotropy were determined as a function of the thickness of the film from measurements of the ferromagnetic absorption in a magnetic field normal and parallel to the surface of the film. Measurements were carried out at a frequency of 9200 Mc/s and on film thicknesses of 180 to 1800 A. A qualitative explanation of the observed dependences is given.

20178 FERROMAGNETIC RESONANCE IN SILICON—IRON CRYSTALS AND ITS RELATION TO DOMAIN STRUCTURE. Ya.S.Shur and O.I.Shiryaeva.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1596-1601 (Dec., 1960). In Russian.

Measurements of the resonance absorption curves at 9370 Mc/s were made on monocrystalline disks of silicon iron, with surface orientations (001) and (011), at different magnitudes and directions of the constant magnetic field in the plane of the specimen. The domain structure was observed by the powder-pattern method. It was established that besides the resonance peak observed in fields sufficient to saturate the crystal, an additional resonance peak may appear in very weak fields in the presence of a multidomain structure, if the orientation of the alternating magnetic field is parallel to the domain walls. This makes possible the use of the phenomenon of ferromagnetic resonance for exhibiting the domain structure and for determining its form qualitatively. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1111-16 (June, 1961)].

20179 DETERMINATION OF PARAMETERS IN EQUATION FOR FERROMAGNETIC RESONANCE OF FERRITES. Z.Frait.
Czech. J. Phys., Vol., 11, No. 1, 1-9 (1961).

The paper describes a new method for determining the parameters in the equation for ferromagnetic resonance; the internal effective field, the spectroscopic splitting factor and the saturation magnetization in polycrystalline magnetically isotropic ferrites. Relations are derived for calculating these parameters by means of the values of the resonance external static fields, which are obtained by measurements on samples having different geometrical shapes and differently arranged static and microwave magnetic fields. The advantages and disadvantages of the method and remarks on the experimental method are given. The paper ends with an example of measurement.

20180 ON THE QUESTION OF THE ANOMALOUS INCREASE IN THE LINE WIDTH OF FERROMAGNETIC RESONANCE ABSORPTION IN FERRITES NEAR THE CURIE POINT. K.P.Belov and V.F.Belov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1425-7 (May, 1961). In Russian.

For abstract, see Abstr. 14773 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1034-6 (Nov., 1961)].

20181 RESONANCE AND MAGNETIC PROPERTIES OF YTTRIUM IRON GARNET AT LOW TEMPERATURES. K.P.Belov, L.A.Malevskaya and V.I.Sokolov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1542-7 (Dec., 1960). In Russian.

The variation in the anisotropy of a 8 500 Mc/s resonance field in a single crystal of yttrium iron garnet on cooling from room temperature to 2° K was studied. At helium temperatures the magnetic anisotropy constant K_1 is 8 to 9 times greater than its room temperature value. The existence of such a sharp variation in K_1 is confirmed by the small slope of the magnetization curves at helium temperatures, measured on polycrystalline specimens. There are sharp maxima in the curves of the temperature dependence of the ferromagnetic resonance absorption line width for single crystals in the region 20°-40°K. These maxima are smaller for polycrystalline specimens and are greatly spread out between 4° and 60°K. It was found that in this temperature range the magnetic viscosity is high (from the static magnetization curves measured). [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1074-80 (June, 1961)].

20182 CAUSES OF ANOMALOUS BROADENING OF FERROMAGNETIC RESONANCE ABSORPTION LINE IN FERRITES NEAR THE CURIE POINT.

K.P.Belov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 711-13 (Feb., 1961).
In Russian.

Arguments are put forward indicating that the principal causes of widening of the ferromagnetic resonance line near the Curie point, in ferrites, are structural factors and magnetic inhomogeneities. This is contrary to previous theories which ascribe the broadening to thermal fluctuations of the spontaneous magnetization. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 497-8 (Aug., 1961)]. R.A.Waldron

20183 MEASUREMENTS OF RESONANCE LINE WIDTH OF FERRITES IN A WAVEGUIDE WITH DIAPHRAGM.

Z.Krzycki.

Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 9, No. 2, 105-10 (1961).

The system used consists of two coaxial rectangular waveguides placed end-to-end and separated by a metal diaphragm. The guides may be placed with their H-planes parallel or perpendicular. In the centre of the diaphragm is a small circular hole containing a transversely-polarized sphere of ferrite. It is shown theoretically that the coupling depends on the properties of the ferrite. Measurements were made at 9300 Mc/s of the coupling coefficient as a function of the polarizing field, with the waveguides either in the parallel or the perpendicular position. From the results, the line widths and effective g factors of various ferrites were deduced. R.A.Waldron

MAGNETIC PROPERTIES AND FERRIMAGNETIC RESONANCE IN POLYCRYSTALLINE $3Y_2O_3.(5-x)Fe_2O_3.xIn_2O_3$. See Abstr. 20143

20184 STUDY OF SATURATION AND MEASUREMENT OF RELAXATION TIMES FOR FERRIMAGNETIC RESONANCE IN YTTRIUM GARNET.

M.Sauzade.

Ann. Phys. (France), Vol. 6, No. 5-6, 595-642 (May-June, 1961).
In French.

An apparatus for measuring relaxation times for ferrimagnetic resonance, using an original method, was designed and constructed. The method eliminates the defects associated with those used by Damon (Abstr. 8538 of 1953) and Bloembergen and Wang (Abstr. 3651 of 1954). Incorporated in the apparatus are:- (1) A high sensitivity electronic fluxmeter. (2) A stabilized electromagnet power supply, giving a field stability of 1 part in 10^5. (3) A frequency stabilizer for an X-band backward wave oscillator, giving a frequency stability of 1 part in 10^5. The experimental results obtained led to the formulation of a law determining the variation of Mz as a function of r.f. field strength for a ferrimagnetic crystal. Using this, relaxation times for single crystal yttrium garnets are determined. It is found that these agree with the Bloch relaxation mechanism, and not with that of Landau and Lifschitz. A simultaneous study of the variation of χ'' as a function of r.f. field gives direct proof of the Suhl [Abstr. 1354B of 1957; Proc. Inst. Radio Engrs (USA), Vol. 44, No. 10, 1270-84 (Oct., 1956)] theory concerning the nonlinear behaviour of ferrites at high microwave signal levels. S.A.Ahern

20185 FERRIMAGNETIC RESONANCE IN RARE-EARTH DOPED YTTRIUM IRON GARNET. II. TERBIUM SUBSTITUTION.

J.F.Dillon, Jr and L.R.Walker.

Phys. Rev. (USA), Vol. 124, No. 5, 1401-13 (Dec. 1, 1961).

For Pt I, see Abstr. 18211 of 1960. The replacement of a small fraction of the yttrium ions in YFe garnet by rare-earth ions produces large effects on the field for ferrimagnetic resonance at low temperatures. Detailed studies were made on the effect of terbium substitution using concentrations from 0.01 to 0.19 at.%. The variation of the field for resonance as a function of applied field direction, of temperature, and of frequency are examined. The field for resonance is calculated by evaluating the r.f. susceptibility and d.c. magnetization of the terbium ions from their energy levels and wave-functions in assumed crystal and exchange fields. The calculated fields show good qualitative agreement with the facts; quantitative agreement would require more flexibility in the choice of a crystal field.

20186 FERRIMAGNETIC RESONANCE IN A SINGLE CRYSTAL OF EUROPIUM—IRON GARNET.

T.Miyadai, H.Takata and Y.Shichijō.

J. Phys. Soc. Japan, Vol. 15, No. 7, 1354 (July, 1960).

20187 ON THE FERRIMAGNETIC RESONANCE OF EUROPIUM IRON GARNET.

W.P.Wolf.

J. Phys. Soc. Japan, Vol. 15, No. 11, 2104 (Nov., 1960).

An attempt is made at a semi-qualitative explanation of the low g value and its temperature variation in europium iron garnet. A.J.Manuel

20188 THE RELATION OF TRANSITION PARAMETERS FOR LINEAR PROCESSES TO MEASURABLE PARAMETERS IN FERRIMAGNETIC RESONANCE.

P.E.Seiden.

J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 259-66 (Jan., 1961).

Expressions are derived for linear processes that relate the fundamental transition parameters for relaxation in ferrimagnetic resonance to measurable parameters such as linewidths and relaxation times. These calculations include the effect of the reaction of spin waves back onto the uniform precession. Previous calculations by others have neglected this effect and the consequences of its neglect are discussed.

20189 INVESTIGATION OF FERRI- AND PARAMAGNETIC RESONANCE IN SPINELS.

J.Voitländer and H.Protschka.

Naturwissenschaften (Germany), Vol. 48, No. 13, 475 (1961).
In German.

Linewidths and g-factors are given for a number of samples of nickel, cadmium and zinc ferrites and cadmium and zinc chromites prepared under various oxygen pressures. P.E.Seiden

20190 RELAXATION ABSORPTION OF ELECTROMAGNETIC ENERGY IN THE ANTIFERROMAGNETIC SUBSTANCE $CoCl_2$.

R.T.Mina.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1293-5 (May, 1961).
In Russian.

The absorption of electromagnetic energy in a single crystal of the antiferromagnetic substance $CoCl_2$, possessing a Curie point at 25° K, was investigated at a frequency of 37300 Mc/s in magnetic fields up to 6 kOe. [English translation in: Soviet Physics—JETP (USA)].

20191 ON THE TEMPERATURE DEPENDENCE OF PARAMAGNETIC RESONANCE IN THE CASE OF THE ISING MODEL.

Y.Y.Lee.

Canad. J. Phys., Vol. 39, No. 12, 1733-7 (Dec., 1961).

The adequacy of the approximation method used by McMillan and Opechowski in their theoretical study of the temperature dependence of the paramagnetic resonance line shape function is very difficult to ascertain for the case of a typical paramagnetic crystal. For this reason the approximation method was investigated for the very simple case of the one-dimensional Ising model. Exact expressions for the line shape function of the model are compared with expressions obtained by the approximation method mentioned above. The agreement between the two expressions is found to be very good in general, and extremely good at very low temperature.

20192 TWO-QUANTUM TRANSITIONS IN ELECTRON PARAMAGNETIC RESONANCE.

J.Burget, M.Odehnal, V.Petříček and J.Šácha.

Czech. J. Phys., Vol. 10, No. 7, 547-9 (1960).

Transitions between the two energy levels of a spin system in a solid in a magnetic field were induced by applying two fields oscillating at 8500 Mc/s and 13 Mc/s, whose magnetic vectors were respectively perpendicular and parallel to the steady field. Absorption or emission was observed at the lower frequency according as the separation of the energy levels was equal to the sum of or the difference between the energies of the two quanta. The behaviour of the transitions was investigated as a function of the microwave field strength, and the frequency and orientation of the magnetic vector of the lower frequency field. C.D.Lustig

20193 THE POSSIBILITY OF OBSERVING THE FINE STRUCTURE OF AN ELECTRONIC AND NUCLEAR SPIN ECHO.

U.Kh.Kopvillem.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 754-6 (March, 1961).

Formulae are obtained for the calculation of the initial intensity and form of the signal of free magnetic precession and spin echo in crystals, determined by the transitions relating to a given allowed component of the fine structure of the nuclear or electron magnetic resonance spectra. There is indicated a method asuring the parameters characterizing the line width of each tructure component of a magnetic resonance spectrum. ish translation in: Soviet Physics—Solid State (USA), Vol. 3, , 549-50 (Sept., 1961)]. N.Davy

194 PARAMAGNETIC EXCITONS IN MOLECULAR CRYSTALS. H.Sternlicht and H.M.McConnell.

em. Phys. (USA), Vol. 35, No. 5, 1793-1800 (Nov., 1961).

The possibility of using electron spin resonance to study para- ıetic excited electronic states of aromatic crystals is explored. limiting cases are considered: On the one hand the excitation gy moves from molecule to molecule by a diffusion process; ıe other the triplet excitation is described by a Frenkel ton. In either case intermolecular propagation of the triplet tation is assumed to proceed through virtual triplet ionization s. The theory of the spin resonance of triplet excitons is loped in some detail. It is shown that there is only a weak endence of the spectra on the k vector of the exciton wave, except n k is near regions of band degeneracies. Band degeneracies e from time-reversal symmetry in benzene, naphthalene, and nene crystals and occur on boundary planes of the first Brillouin e. A spin Hamiltonian is calculated for these three aromatic stals for most k vectors which are far removed from regions of d degeneracy. Two-line spectra (with no hyperfine structure), resenting an average over the molecular sites in the unit cell, obtained. Scattering of the exciton wave by lattice vibrations cause line broadening and also can serve as a mechanism for n lattice relaxation.

20195 ELECTRON PARAMAGNETIC RESONANCE FOR METALS WITH TWO CONDUCTION BANDS. T.Murao.

Phys. Soc. Japan, Vol. 16, No. 10, 1940-7 (Oct., 1961).

Theoretical expressions are given by assuming that the Bloch e equations involving interband "cross" terms and diffusion terms applicable. Some typical examples of the absorption curve are own to illustrate the interband "cross" effect and the diffusion ect. A possible determination of the diffusion constants of the electrons in transition metals is discussed.

20196 ROTATIONAL PROPERTIES OF PARAMAGNETIC RESONANCE SPECTRA OF NON-CUBIC CRYSTALS.

Sachs.

Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 291-305 (Oct., 1960).

The complete symmetry group for each of the twenty-seven n-cubic point groups is exploited in a derivation of the rotational roperties of paramagnetic resonance spectra of non-cubic crystals. he energy eigenvalues for the magnetic substates of the ground- ate energy level of the paramagnetic crystal (in a uniform agnetic field) are derived as a function of the polar and azimuthal ıgles which locate the direction of the applied magnetic field with espect to the crystal coordinate system. The theory, which gives ıe line positions to second order in $|\langle e\phi_C\rangle|/|\langle\mu\cdot H\rangle|$, is appli- able to an analysis of microwave spectra in which the non-cubic art of the electrostatic potential energy of the crystal ($e\varphi_C$) is mall compared with the magnetic energy term ($-\mu\cdot\vec{H}$). The esults of the general formulation are applied explicitly to the case n which the local electrostatic crystalline potential field at the nagnetic ion site is any of the trigonal or hexagonal symmetry types.

20197 PARAMAGNETIC RESONANCE ABSORPTION IN SEVERAL ELECTRON-IRRADIATED MOLECULAR CRYSTALS. P.E.Wigen and J.A.Cowen.

J. Phys. Chem.Solids (GB), Vol. 17, No. 1-2, 26-33 (Dec., 1960).

Paramagnetic resonance in a series of hydrated and deuterated molecular crystals irradiated with 1 MeV electrons at liquid air temperature is associated with a hole localized on the hydrogen bonded oxygen of the oxyion group. In each case hyperfine structure due to the hydrogen bonding proton is analysed with the aid of a Hamiltonian containing an anisotropic term and an isotropic term and the results interpreted to give the relative position of the nucleus and the paramagnetic centre.

20198 THE EFFECT OF SHORT-RANGE ORDER ON PARAMAGNETIC RESONANCE. Y.Ōsaka.

Progr. theor. Phys. (Japan), Vol. 25, No. 3, 510-12 (March, 1961).

The variation of line width of the paramagnetic resonance with temperature is calculated taking into account the nearest neighbour interaction only, and assuming that exchange is stronger than magnetic dipole—dipole interaction. The correlation function determining the line width is approximated to Gaussian form. The expansion method of Opechowski (1937) is used and quantities of higher than fourth order in J/kT are neglected. J.M.Baker

20199 EFFECT OF UNRESOLVED STRUCTURES ON THE LINE WIDTH IN ELECTRONIC PARAMAGNETIC RESONANCE. R.Kh.Timerov.

Zh. eksper. teor. Fiz (USSR), Vol. 40, No. 4, 1101-5 (April, 1961). In Russian.

The line width in solid paramagnetic salts is computed by taking into account the unresolved fine and hyperfine structures. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 777-9 (Oct., 1961)].

20200 PARAMAGNETIC ELECTRON RESONANCE AND ITS APPLICATION TO THE STUDY OF SOME PHYSICO-CHEMICAL PHENOMENA. J.Roch.

Ann. Phys. (France), Vol. 5, No. 9-10, 1401-47 (Sept.-Oct., 1960). In French.

The principles of paramagnetic electron resonance are reviewed and the development of a spectrometer for its measurement described. The thermal behaviour of vanadyl sulphate and of vanadium oxides was studied using this technique in conjunction with measurement of paramagnetic susceptibility. Results obtained from measurements on γ-irradiated polyvinyl chloride are given and an attempt made to interpret the effect of the radiation. G.I.W.Llewelyn

20201 DIRECT FIELD EFFECTS IN ELECTRON PARAMAGNETIC RESONANCE HYPERFINE SPECTRA.

J.A.Weil and J.H.Anderson.

J. chem. Phys. (USA), Vol. 35, No. 4, 1410-17 (Oct., 1961).

The electron paramagnetic resonance spectrum exhibiting hyperfine effects from one nucleus is discussed for the case when the nuclear spin interacts appreciably not only with the electron magnetic moment but also directly with the applied magnetic field. The predicted hyperfine structure consists, in general, of $2S(2I+1)^2$ lines. The angular dependence of the intensities and splittings is investigated; nodes in the splitting are found to be possible even when the eigenvalues of the hyperfine splitting tensor are nonzero. When the direct-field interaction is large, $2I+1$ principal hyperfine lines occur, flanked by weaker "outrider" lines. Another mechanism for producing outrider lines in high direct fields, the nuclear quadrupole interaction with an electric field gradient, is discussed. Magnetic resonance studies of colour centres in germanium-doped quartz demonstrate some of the predicted effects.

20202 PARAMAGNETIC RESONANCE OF COBALT IN CADMIUM CHLORIDE AND CADMIUM BROMIDE.

K.Morigaki.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1639 (Aug., 1961).

The Co^{2+} ion was measured as an impurity at 9300 Mc/s below 40°K. The spin Hamiltonian parameters are given for Co^{2+} in $CdCl_2$ at 14°K and in $CdBr_2$ at 16°K. Some saturation experiments are reported and spin lattice relaxation time temperature dependence is discussed. Forbidden transitions for H_1 not perpendicular to H_0 are observed and show partial agreement with theory (Abstr. 5654 of 1960). J.G.Powles

20203 PARAMAGNETIC RESONANCE OF X-IRRADIATED CaF_2:Tm AND OF CaF_2:Yb. W.Hayes and J.W.Twidell.

J. chem. Phys. (USA), Vol. 35, No. 4, 1521-2 (Oct., 1961).

A single crystal of CaF_2 containing 0.05% Tm showed no X-band e.s.r. spectrum down to 20°K. After X-irradiation at 77°K an isotropic spectrum with a two-line hyperfine structure ($g = 3.453 \pm 0.003$ and $A = 368 \pm 2 \times 10^{-4}\ cm^{-1}$) is observed which is attributed to Tm III situated in a cubic crystal field. This spectrum and that of the isoelectronic YbIV ion were measured at both X- and K-band (for YbIV $g = 3.443 \pm 0.002$). The values of the g and A parameters are discussed and compared with related measurements by other authors on Tm and Yb. J.M.Baker

20204 SPIN-ECHO MEASUREMENT OF THE SPIN—LATTICE AND SPIN—SPIN RELAXATION IN Ce^{3+} IN LANTHANUM MAGNESIUM NITRATE.

J.A.Cowen and D.E.Kaplan.

Phys. Rev. (USA), Vol. 124, No. 4, 1098-1101 (Nov. 15, 1961).

Fast-resolution time-pulsed microwave apparatus was used to measure the spin—spin and spin—lattice relaxation. T_1, measured by a three-pulse sequence, varies as $T_1 = 6 \times 10^{-10} \exp(34/T)$ over a range of four orders of magnitude from 4° to 1.8°K but changes less rapidly below this temperature. T_2, measured by the decay of the echo following a two-pulse sequence, is approximately 1 μsec at 1.4°K and drops very rapidly above 3°K. The accuracy of the numerical values does not seem to be seriously affected by spectral diffusion within the line, but the echo envelope exhibits a striking amplitude modulation which is attributed to surrounding nuclear moments, and which makes accurate determination of T_2 quite difficult.

20205 ELECTRON SPIN RESONANCE IN NATURAL CHRYSOBERYL [Al_2BeO_4].

V.M.Vinokurov, M.M.Zaripov, V.G.Stepanov, Yu.E.Polskii, G.K.Chirkin and L.Ya.Shekun.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2475-9 (Aug., 1961). In Russian. English translation in: Soviet Physics—Solid State (USA).

20206 PARAMAGNETIC RESONANCE OF CHROMIC IONS IN DOUBLE NITRATE CRYSTALS AND FROZEN SOLUTION.

J.W.Culvahouse.

Phys. Rev. (USA), Vol. 124, No. 5, 1413-17 (Dec. 1, 1961).

Chromic ions are shown to enter double nitrate crystals in two different interstitial sites, and the spin Hamiltonian parameters for these ions were determined. It is also shown that cloudly double nitrate crystals contain occluded solution and the amount of solution contained in a number of crystals was measured. The paramagnetic resonance properties of frozen samples of the solution from which the chromium-doped double nitrate crystals were grown have been investigated. The results are compared with the nuclear orientation results for Cr^{51} in cerium magnesium nitrate obtained by Kaplan and Shirley (Abstr. 7518 of 1961). The utility of frozen solutions for nuclear orientation experiments is discussed.

20207 PARAMAGNETIC RESONANCE SPECTRA OF CHROMIUM III AND MANGANESE IV HEXAFLUORIDE IONS: CrF_6^{3-} AND MnF_6^{2-}.

L.Helmholz, A.V.Guzzo and R.N.Sanders.

J. chem. Phys. (USA), Vol. 35, No. 4, 1349-52 (Oct., 1961).

The spectra of the ions in dilute solution in diamagnetic solids show fluorine hyperfine structure with both isotropic and anisotropic components. The anisotropic coupling constants are of the same order of magnitude as in the case of FeF_6^{3-}, but have the opposite sign indicating important contributions of π-bonding electrons. Accordingly, the previously estimated degree of σ bonding in FeF_6^{3-} is certainly too small, and estimates of the fluorine atomic orbital coefficients for the compound are made on the basis of the data presented here. The isotropic effects are to be understood in terms of configurational interactions. The isotropic coupling constants for the two ions have opposite signs and at present this difference cannot be rationalized.

20208 ELECTRON SPIN RESONANCE IN POWDERS.

G.Burns.

J. appl. Phys. (USA), Vol. 32, No. 10, 2048-50 (Oct., 1961).

The use of powders for electron spin resonance measurements rather than single crystals is pointed out and demonstrated. As an example, the values of g and D for the spin-Hamilton

$$g\beta\, H.S + D[S_z^{\,2} - \tfrac{1}{3}S(S+1)]$$

for Cr^{3+} and Mn^{2+} in two compounds are measured. The agreement with published single crystal work is good. The use of powders for e.s.r. should permit the study of a number of groups of compounds which can be prepared in single crystal form only with great difficulty. There are, however, two main drawbacks:- (i) The small signal to noise ratio. (ii) The observed lines are wider than for single crystal samples — so that any of the fine details of spectra which require measurements more accurate than a line breadth will be lost. S.A.Ahern

20209 THE ROLE OF PHONONS IN PARAMAGNETIC RELAXATION.

B.W.Faughnan and M.W.P.Strandberg.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 155-66 (April, 1961).

The coupled spin—lattice bath system is investigated under conditions of microwave power saturation and the conditions for the existence of a steady-state nonthermal equilibrium phonon distribution are determined. The spin—lattice bath equations are solved numerically for a few special cases involving a nonequilibrium distribution of phonons. The results of an experiment designed to detect the presence of nonequilibrium phonons are reported. No indication of the presence of such phonons was found. The expe ments were performed using Cr^{3+} impurities in MgO, Al_2O_3 and $K_3Co(CN)_6$ and at T = 4.2° and 2°K. The sensitivity of the experi ment was such that for ruby a phonon temperature rise of ΔT = 0.005T could have been observed. Finally, the validity of theory, in view of the experimental results, is discussed.

20210 ELECTRON PARAMAGNETIC RESONANCE IN A GAMMA-IRRADIATED SINGLE CRYSTAL OF GLYC

G.Lomaglio and J. Uebersfeld.

J. Phys. Radium (France), Vol. 21, No. 11, 802-4 (Nov., 1960). In French.

An analysis of the orientation-dependent hyperfine structure made. It is believed that the spectra are the superposition of (1) a spectrum of six equidistant lines due to NH_3CH_2, in which additional close triplet splitting is ascribed to nitrogen nuclear sp coupling, and (2) a triplet spectrum due to CH_2 or CH_2CO_2. Sinusoidal variations in spacing with crystal orientation are compati with imprisonment of radicals in a monoclinic lattice. Values of coupling constants are assigned on the basis of assumptions, whi include equality of the proton couplings in a given radical. The values are reasonable. J.Sher

20211 THE SPIN HAMILTONIAN APPROPRIATE TO A SINGLE CRYSTAL BELONGING TO THE ORTHORHOMBIC SYSTEM.

C.Lomaglio.

J. Phys. Radium (France), Vol. 21, No. 11, 804-6 (Nov., 1960). In French.

General expressions are derived for the energy levels of a paramagnetic centre, for use in interpreting paramagnetic resonance spectra of radicals in crystals of low symmetry (see preceding abstract). Anisotropic spin—spin interactions and effects of one quadrupole nucleus are taken into account. Calcul tions are detailed for a first-order treatment. Effects of crysta field are extended to second order in a formula agreeing with ear work, and a second-order formula incorporating quadrupole effe is given for the first time. Extension of the treatment of hyperfi interactions to second order is complex, but has been carried through (no results stated). J.Sher

ELECTRON SPIN RESONANCE STUDIES OF IMPURITY IO IN MAGNESIUM OXIDE. See Abstr. 17536

20212 ANISOTROPIC BROADENING OF LINEWIDTH IN TH PARAMAGNETIC RESONANCE SPECTRA OF MAGNETICALLY DILUTE CRYSTALS.

D.Shaltiel and W.Low.

Phys. Rev. (USA), Vol. 124, No. 4, 1062-7 (Nov. 15, 1961).

The effects of mosaic structure on the anisotropic broadeni of the linewidth in paramagnetic resonance spectra of dilute crystals is investigated. A general formula for the line shape a the linewidth at half maximum is derived. The half-width of the spectrum of Gd^{3+} in a single crystal of ThO_2 is measured as a function of the angle of the magnetic field with respect to the cub axes. Good agreement is found with the above theory. The aver deviation of the crystallites from the symmetry axis is found to about 0.12°. Small deviations from the agreement indicate a compensating defect approximately along the [100] direction whi gives rise to a small axial distortion.

20213 SOME REMARKS ON THE SPECTROSCOPIC STATE PARAMAGNETIC IONS IN DILUTE ALLOYS EXHIBITING RESISTIVE ANOMALIES.

E.W.Collings, F.T.Hedgcock and T.Sakudo.

Canad. J. Phys., Vol. 39, No. 8, 1233-5 (Aug., 1961).

In electron spin resonance experiments on dilute alloys of Fe and Co in Au and Cu, no resonance due to paramagnetic atom solid solution could be found. Possible spectroscopic states to account for these observations and also the low temperature resistance anomalies to these alloys are discussed. H.My

20214 SPLITTING OF ELECTRON SPIN RESONANCE LINE BY AN APPLIED ELECTRIC FIELD.

G.W.Ludwig and H.H.Woodbury.

Phys. Rev. Letters (USA), Vol. 7, No. 6, 240-1 (Sept. 15, 1961).

The resonances of Fe^0 and Fe^+ ions in interstitial sites in silicon were observed while electric fields up to 12 kV cm^{-1} wer applied. The sites lacked inversion symmetry. The Fe^0 resona d a fine structure splitting, and the Fe^+ resonance a g-shift, rtional to the electric field. This is the first report of such s.

E.F.W.Seymour

215 LINEAR EFFECT OF APPLIED ELECTRIC FIELD IN ELECTRON SPIN RESONANCE. F.S.Ham.

Rev. Letters (USA), Vol. 7, No. 6, 242-3 (Sept. 15, 1961).

xpressions for the spin Hamiltonian and energy levels of group transition metal ions in interstitial sites in silicon, in resence of an applied electric field, are derived and used to ss the results of Ludwig and Woodbury (see previous abstract).

E.F.W.Seymour

216 PASSAGE EFFECT IN THE ELECTRON SPIN RESONANCE OF Fe-DOPED SILICON. T.Igo.

ys. Soc. Japan, Vol. 16, No. 7, 1472 (July, 1961).

The effect was observed and a relaxation time T_1 of the order of sec was estimated.

G.C.Williams

217 PARAMAGNETIC RESONANCE OF THE ANTIMORPH OF THE F-CENTER. W.Känzig.

hys. Chem. Solids (GB), Vol. 17, No. 1-2, 80-7 (Dec., 1960).

LiF crystals, X-rayed at 77°K and then warmed up to a perature between 130° and 220°K, contain a new kind of a ped-hole centre. Its electronic structure was studied by means aramagnetic resonance. The centre appears to consist of a trapped at a Li vacancy, and thus it may be considered as the imorph" of the F-centre. However, the electron deficiency is lized on but two neighbouring fluoride ions adjacent to the Li ancy, so that the symmetry is lower than that of the F-centre. new centre is closely related to the self-trapped hole, as it also be described as a F_2^- molecule-ion. However, owing to vicinity of the Li vacancy the molecular bond is "bent", so that centre has the symmetry of an isosceles triangle lying in a) plane with the base along a [110] axis. The thermal stability igher than that of the self-trapped hole because of the Coulomb d of the vacancy. The main optical absorption band is probably tred at about 3400 A just as for the self-trapped hole. So far, is the only alkali halide in which a centre of this type could be nd.

0218 PARAMAGNETIC RESONANCE STUDY OF RADIATION DAMAGE IN LITHIUM FLUORIDE. W.Känzig.

Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 88-92 (Dec., 1960).

The low-temperature annealing processes in LiF crystals rayed at 77°K were studied by means of paramagnetic resonance. ur types of hole centres (V-type centres), the structures of which known from previous work, play an important part; namely, self-trapped holes, the H-centres, the V_F-centres and the -centres. The relative concentrations of these defects were asured after X-irradiation at 77°K and after subsequent pulse nealing at successively higher temperatures. Four temperature ervals were found in which the paramagnetic resonance spectra dergo significant changes in intensity. There seems to be a e-to-one correspondence between the annealing processes observ- by means of paramagnetic resonance and those detected by other vestigators by means of thermoluminescence, conductivity, anges of the optical absorption and of the crystal volume.

20219 ELECTRON SPIN RESONANCE IN NEUTRON IRRADIATED LiF. K.Morigaki.

Phys. Soc. Japan, Vol. 16, No. 8, 1645 (Aug., 1961).

A neutron-irradiated (1 and 2 × 10^{18} n.v.t.) single crystal LiF was studied at 4.2° and 1.4°K. Partially resolved orientation-pendent hyperfine splitting was observed. The line saturates in complex manner. A heat-treated sample behaves differently. It thought that two types of centre exist, one being isolated -centres.

J.G.Powles

20220 PARAMAGNETIC RESONANCE OF Mn^{2+} IN DOLOMITE AND MAGNESITE.

.M.Vinokurov, M.M.Zaripov and V.G.Stepanov.

h. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1552-3 (Dec., 1960). Russian.

The hyperfine structure spectrum of the electron paramagnetic esonance of Mn^{2+} in dolomite and magnesite was studied both xperimentally and theoretically. The values of the parameters f the spin Hamiltonian describing the position of the lines in the pectrum is determined. [English translation in: Soviet Physics— ETP (USA), Vol. 12, No. 6, 1081 (June, 1961)].

20221 ELECTRON SPIN RESONANCE OF MANGANESE IN $MgCl_2$.

K.Fukuda, H.Matsumoto, T.Takagi and Y.Uchida.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1256 (June, 1961).

Electron spin resonance experiments at 1.2 cm were carried out on a $MgCl_2$ single crystal containing 1 mol.% $MnCl_2$. The spectrum consists of a broad line of about 450 Oe on which are superimposed many sharp lines of about 40 Oe. The sharp lines were analysed in terms of the Mn ion by using the following Hamiltonian,

$$\mathcal{H} = g\beta HS + DS_Z^2 + E(S_X^2 - S_y^2) + ASI,$$

where $A = -82 \times 10^{-4}\ cm^{-1}$; $|D| = 140 \times 10^{-4}\ cm^{-1}$; $E = 0$; and $g = 2.002$. The underlying broad line is unexplained. X-ray irradiation induced a change in the spectrum and the introduction of new lines. The broad line and the changes due to irradiation are presently under investigation.

P.E.Seiden

20222 ELECTRON SPIN RESONANCE IN F^--CENTRES.

L.A.Shul'man.

Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 1, 117-19 (1960). In Ukrainian.

General theoretical expressions and calculations for NaCl and KCl are given.

LOW TEMPERATURE PARAMAGNETIC RESONANCE OF TRAPPED O_2. See Abstr. 19664

20223 PARAMAGNETIC RESONANCE OF TRIVALENT Pm^{147} IN LANTHANUM ETHYL SULFATE.

H.J.Stapleton, C.D.Jeffries and D.A.Shirley.

Phys. Rev. (USA), Vol. 124, No. 5, 1455-7 (Dec. 1, 1961).

Paramagnetic resonance absorption at 3 cm wavelengths was observed for trivalent Pm^{147} in a single crystal of lanthanum ethyl sulphate at 4.2°K. The observed spectra correspond to eight h.f.s. transitions of a system described by the spin Hamiltonian

$$\mathcal{H} = g_{||}\beta H_Z S_Z + AI_Z S_Z + \Delta_X S_X + \Delta_y S_y,$$

with $S = \frac{1}{2}$, $I = \frac{7}{2}$, $|g_{||}|_2 = 0.432 \pm 0.004$, and $|A|/h = 496.6 \pm 4$ Mc/s. The value of $\Delta = (\Delta_X^2 + \Delta_y^2)^{1/2}$ is not directly measured in this experiment, but is known from nuclear alignment to be $\Delta/k = 0.02 \pm 0.01$°K. The line shapes exhibit an asymmetry typical of non-Kramers doublets and become unobservable in a few days presumably due to broadening from radiation damage to the crystal. The experimental value of $g_{||}$ is found to be in reasonable agreement with that predicted from crystal field theory. Effects from higher J level admixtures are taken into account in estimating the nuclear magnetic moment value $|\mu(Pm^{147})| = 3.0 \pm 0.3$ n.m.

20224 INTERACTION EFFECTS IN POTASSIUM FERRICYANIDE. T.Ohtsuka.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1549-60 (Aug., 1961).

The character and magnitude of the exchange interaction between the ferric ions in $K_3Fe(CN)_6$ were investigated by (1) observation of the paramagnetic resonance spectrum of coupled Fe—Fe pairs in semidilute crystals and, (2) adiabatic demagnetization of concentrated crystals. The results show that the exchange between magnetically similar ions contains an appreciable anisotropic part of the order of 0.07 cm^{-1}. No lines corresponding to dissimilar ion pairs were found. From the two types of experiments, it is concluded that the isotropic part of the exchange between similar ions, J_S, is about 0.25 cm^{-1} and that the exchange between dissimilar ions is very small.

20225 TEMPERATURE DEPENDENCE OF E.S.R. LINEWIDTH IN $K_2CuCl_4.2H_2O$. H.Abe.

J. Phys. Soc. Japan, Vol. 16, No. 4, 836 (April, 1961).

Some preliminary, unexplained observations at 24 Gc/s are reported. For H parallel to the 110 axis the linewidth decreased from 500 Oe at 300°K to 120 Oe at 100°K; for H parallel to the 001 axis the line-width was about 30 Oe independent of temperature.

E.F.W.Seymour

20226 E.S.R. SPECTRA OF IRRADIATED POLYVINYLALCOHOL AND ITS RELATED COMPOUNDS. S.Ogawa.

J. Phys. Soc. Japan, Vol. 16, No. 7, 1488-9 (July, 1961).

The ESR spectra of some γ-irradiated alcohols and of irradiated PVA fibre are described and discussed.

R.F.Barrow

20227 ELECTRON SPIN RESONANCE SPECTRUM OF STRETCHED POLYETHYLENE.

D.Libby and M.G.Ormerod.
J. Phys. Chem. Solids (GB), Vol. 18, No. 4, 316-19 (March, 1961).

The ESR spectrum of stretched polyethylene, irradiated at 77°K, was observed at various orientations of the applied magnetic field with respect to the axis of stretch. The different spectra resulting are explained in terms of the anisotropy of the α-hydrogen atom which was resolved due to the orientation of the molecule chains on stretching. Values obtained for the α-hydrogen hyperfine component separation are in good agreement with those found by other workers for irradiated single crystals.

20228 E.S.R. OF IRRADIATED DPPH PROTECTED BY POLYSTYRENE.

K.Masuda and T.Suita.
J. Phys. Soc. Japan, Vol. 16, No. 4, 837-8 (April, 1961).

The number of unpaired electrons, determined by e.s.r., in DPPH irradiated by γ-rays passed through a maximum as the dose was increased. For DPPH in polystyrene the maximum occurred for higher doses. It is concluded that the polystyrene did not merely shield the DPPH but also reduced the production and recombination coefficients of unpaired electrons by preventing coagulation of DPPH molecules. E.F.W.Seymour

20229 ELECTRON SPIN RESONANCE IN SEMICONDUCTING RUTILE.

P.F.Chester.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2233-6 (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). The e.s.r. spectra of oxygen-deficient and doped rutile were investigated at liquid helium temperatures. Niobium and tantalum are shown to give rise to the donors Nb^{4+} and Ta^{4+} rather than Ti^{3+}. The spectrum of reduced rutile depends on the method of reduction. Reasons for this are discussed. Under certain circumstances, involving hydrogen reduction, a particularly simple spectrum is observed. This degenerates and is replaced by a single line as the temperature is raised. A similar effect is obtained by increasing the concentration of centres. Possible assignments are discussed. Vacuum reduction results in distinctly different spectra which persist to higher temperatures. Resistivity measurements indicate a higher activation energy, by a factor of three, for vacuum-reduced samples.

20230 ELECTRON SPIN RESONANCE STUDIES OF GAMMA-IRRADIATED SINGLE CRYSTALS OF SUCROSE.

H.Ueda, Z.Kuri and S.Shida.
J. chem. Phys. (USA), Vol. 35, No. 6, 2145-7 (Dec., 1961).

The electron spin resonance of gamma-irradiated single crystals of sucrose was measured at 9400 Mc/s for various orientations in the magnetic field. The variations of the resonance with angle were greatest for rotation of the crystal about its b axis, which was kept perpendicular to the magnetic field. The anisotropic hyperfine structure was observed to vanish when the magnetic field is applied perpendicular to the (b,c) plane. It was ascertained that the radical formed is the type X—CH—Y, which had been proposed by Williams et al. from the data obtained from the polycrystalline samples.

20231 SPIN RESONANCE OF ELECTRONS ON DONORS IN p-TYPE SILICON.

G.Bemski and B.Szymanski.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 173-5 (Dec., 1960).

Resonance was observed in compensated p-type samples when illuminated by 1 μ radiation at helium temperatures. The signal amplitude remained constant for several hours after removal of the illumination. The number of donors was estimated by comparing the signal amplitude with that observed in samples of known donor concentration; it is considered that this technique leads to a more accurate measure of the compensation in p-type silicon than determinations of Hall coefficient. An estimate was made of lifetime ($\approx 10^{-9}$ to 10^{-8} sec) and the capture cross-section for electrons at neutral acceptors ($\approx 10^{-14}$ cm^2 at 1.2°K). D.J.Oliver

20232 ELECTRON SPIN RESONANCE EXPERIMENTS ON DONORS IN SILICON. III. INVESTIGATION OF EXCITED STATES BY THE APPLICATION OF UNIAXIAL STRESS AND THEIR IMPORTANCE IN RELAXATION PROCESSES.

D.K.Wilson and G.Feher.
Phys. Rev. (USA), Vol. 124, No. 4, 1068-83 (Nov. 15, 1961).

For previous work, see Abstr. 9823-4 of 1959. The excited states of the antimony, phosphorus, and arsenic impurities in silicon were investigated by subjecting samples to a uniaxial stress and observing the change in the electron spin resonance spectru The experiments were performed at 1.25°K and ~ 9000 Mc/s on silicon samples subjected to strains of up to 10^{-3}. From the reduction in the hyperfine splitting and the observed g anisotropy under strain the following results were deduced. For a deforma potential of 11 eV, the valley—orbit splitting (i.e., singlet—doubl spacing) for phosphorus was found to be 0.015 eV, for arsenic 0.023 eV, and for antimony 0.013 eV. For the difference in g va with H parallel ($g_{\parallel}$) and H perpendicular ($g_{\perp}$) to the valley axis, authors obtained, for phosphorus-doped silicon, $g_{\parallel} - g_{\perp} = (1.04 \pm 0.04) \times 10^{-3}$. The observed g shifts with strains along different crystallographic directions revealed the presence of tw distinct spin—lattice relaxation (T_S) mechanisms. These were verified and compared with the theory of Roth (Abstr. 11613 of 1960) and Hasegawa (Abstr. 11612 of 1960). The effect of applie strains on the mutual electron—nuclear spin flip rate (T_X) was demonstrated. The importance of strain experiments in unravell relaxation mechanisms is discussed.

20233 ELECTRON SPIN RESONANCE STUDIES IN SiC.

H.H.Woodbury and G.W.Ludwig.
Phys. Rev. (USA), Vol. 124, No. 4, 1083-9 (Nov. 15, 1961).

Electron spin resonance studies were made on boron and nitrogen as impurities in 6H silicon carbide. It is concluded that both impurities substitute for carbon and that they occupy the thr nonequivalent carbon sites with equal probability. Hyperfine structure is well resolved for both species. The pattern for bor occupying one site is unusual in that the hyperfine splitting vanis when the applied field is about 50° from the hexagonal axis of the crystal. The nitrogen hyperfine structure is interpretable in ter of some s character for the unpaired electron, while the boron hyperfine structure indicates predominantly p character.

20234 ON THE THEORY OF PARAMAGNETIC RESONANC OF Ti AND Co IONS IN CORUNDUM.

S.A.Al'tshuler and M.M.Zaripov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 377-9 (Jan., 1961).
In Russian.

It has been found experimentally that the magnetic propertie of Ti and Co ions in Al_2O_3 crystals differ appreciably from the properties of these ions in other crystals. In the case of Ti in Al_2O_3, a large g-factor anisotropy has been measured: $g_{\parallel} = 1.06$ $g_{\perp} < 0.1$. This is unusually large for iron group ions possessing odd number of electrons. Measurements of T_1 show an increase from 5×10^{-8} sec at 9°K to 0.1 sec at 1.55°K, showing that even liquid helium temperatures, two phonon processes play the predominant role—as a result of which $T_1 \sim T^{-7}$. For Co ions in Al_2O_3, measurements of T_1 show that, whilst at 25°K the spin—lattice coupling of the Co^{2+} ions is much stronger than of Cr^{3+} ions, at liquid helium temperatures T_1 for Cr^{3+} ions is much shorter than for the Co^{2+} ions. The mechanism responsible for is discussed. [English translation in Soviet Physics—JETP (USA Vol. 13, No. 1, 257-8 (July, 1961)]. S.A.Al

20235 ON THE ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF V^{3+} IN CORUNDUM (Al_2O_3).

D.K.Ray.
Nuovo Cimento (Italy), Vol. 20, No. 6, 1148-56 (June 16, 1961).

Detailed investigations of the e.p.r. spectra of V^{3+} in corund were made taking into account the effect of excited ^3P state, trigonal field mixing, and also covalent bonding. Trigonal splitti is found to be of the order of 400 cm^{-1}. Second-order g-factors arising from the effect of higher orbital states through spin-orbi interaction are shown to have very significant effect on the evaluation of the covalent bonding factors.

20236 ANALYSIS OF THE ELECTRON PARAMAGNETIC RESONANCE SPECTRUM OF V^{3+} IN CORUNDUM (α-Al_2O_3).

D.K.Réi.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2214-22 (Aug., 1961).
In Russian.

A theoretical study is made of the two-electron V^{3+} system a crystal field of predominantly cubic symmetry plus a small trigonal component. The author takes into account the influence covalent bonding between the metal and the surrounding oxygen atoms on the parameters of the spin Hamiltonian. Extensive tab of matrix elements are given. After making some simplifying assumptions about the relative contributions of σ-bonding and π-bonding terms, these tables are used to derive theoretical exp sions for the modified g-factors $g_{\parallel}$ and $g_{\perp}$, the zero-field splitti

meter D and the hyperfine interaction parameters A and B. T experimental paramagnetic data are used to deduce a probable v of 361.4 cm^{-1} for the splitting of the $^3T_1$ doublet. See also f wing abstract. [English translation in: Soviet Physics—Solid S (USA)].
R.Hayward

237 THEORY OF COVALENT BONDING IN THE SALTS OF COBALT AND AN ANALYSIS OF THE ELECTRON AMAGNETIC RESONANCE SPECTRUM OF Co^{++} IN CORUNDUM.

D Réi.

F tverdogo Tela (USSR), Vol. 3, No. 8, 2223-39 (Aug., 1960).

ussian.

A theoretical study is made of the energy levels and e-functions of Co^{++} in crystal fields of (a) cubic plus agonal symmetry and (b) cubic plus trigonal symmetry, uding the effects of covalent bonding with the surrounding nds. After extensive calculation (see preceding abstract) author derives complicated expressions for $g_{\parallel}$, $g_{\perp}$, A and B and lies them to discussing the spin resonance spectrum of the two es of centre present in cobalt-doped corundum. Some predictions made of parameters at present unknown, and suggestions are de for future experimental work. [English translation in: Soviet ysics—Solid State (USA)].
R.Hayward

0238 ELECTRONIC PARAMAGNETIC RESONANCE IN THE V^{3+} ION IN CORUNDUM.

M.Zverev and A.M.Prokhorov.

. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1016-18 (April, 1961). Russian.

The spin Hamiltonian constant $g_{\perp}$ was determined experiment-y. A theoretical interpretation of the spin Hamiltonian constants $g_{\parallel}$ and $g_{\perp}$ is presented. The value of the trigonal crystal field rameter is found to be $\Delta = -280\ cm^{-1}$ and the spin—orbit coupling nstant $\lambda = +38\ cm^{-1}$. [English translation in: Soviet Physics—TP (USA), Vol. 13, No. 4, 714-15 (Oct., 1961)].

20239 THE NUCLEAR PARAMAGNETIC RELAXATION TIMES OF WATER ADSORBED BY ALUMINIUM OXIDE.

.Winkler.

. Naturforsch. (Germany), Vol. 16a, No. 8, 780-90 (Aug., 1961). German.

Proton relaxation times in water adsorbed by aluminium oxide wder were investigated by the spin echo technique. The adsorption nditions were varied from approximately monolayer adsorption to aturation adsorption. Experimental results are interpreted in rms of the existence of micro- and macropores of the adsorber, nd in terms of hindered mobility of the water molecules in the irst monolayer. These conditions relate to the transverse relaxa-ion time. The longitudinal relaxation time was determined rincipally by paramagnetic (iron) impurities in the adsorber.
P.M.Parker

20240 PARAMAGNETIC RESONANCE OF DONORS IN ZINC OXIDE. J.Schneider and A.Räuber.

Z. Naturforsch. (Germany), Vol. 16a, No. 7, 712-14 (July, 1961). In German.

The paramagnetic resonance signals from single crystal and powdered samples of zinc oxide were greatly enhanced after the samples had been doped by annealing at high temperatures in zinc vapour and quenching. The g-values and line widths were measured at X-band at 300° and 77°K. The results indicate that the resonance arises from paramagnetic donors, but it is not certain whether the unpaired electron is attached to an interstitial zinc ion or to an oxygen vacancy. No Zn^{67} hyperfine structure was observed.
C.D.Lustig

20241 CROSS-RELAXATION IN SUBSTANCES CONTAINING PARAMAGNETIC CENTRES OF TWO TYPES.

G.F.Mekhtiev.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3137-41 (Oct., 1961). In Russian.

This theoretical discussion aims to establish the conditions in which cross-relaxation can be demonstrated in a continuous saturation experiment. The separate spin—lattice relaxation times of the two types of centre must be very unequal; the separation of some pairs of levels in the two centres must be nearly equal; the g-factor in one centre should be strongly anisotropic so that a suitable magnitude and direction of magnetic field makes two transitions of the different centres coincide. It appears that these conditions are met in corundum containing chromium and titanium, and calculation gives a cross-relaxation time of the order of 5 μsec for a concentration of chromium ions of 0.1%. At low concentrations the line shape remains Gaussian; at high concentrations it is determined by the overlap integral. [English translation in: Soviet Physics—Solid State (USA)].
G.Wyllie

20242 THE HYPERFINE DIPOLE—DIPOLE SPIN—LATTICE RELAXATION OF LOCALIZED ELECTRONIC CENTRES.

V.Ya.Zevin.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 911-17 (March, 1961). In Russian.

The magnetic dipole—dipole contribution to the spin—lattice relaxation of localized electron spins is discussed. This yields anisotropic relaxation times T_S (no nuclear spin changes) and T'_X (change in orientation by one nucleus along with the electron). For an F-centre in KCl at 4°K and 3000 G, the maximum values are $T_S \cong 30$ hours, $T'_X \cong 10$ hours. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 662-6 (Sept., 1961)].
I.D.C.Gurney

20243 THE THEORY OF SPIN—SPIN INTERACTIONS IN CRYSTALS CONTAINING RARE-EARTH IONS.

L.K.Aminov and A.K.Morocha.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2480-1 (Aug., 1961). In Russian. English translation in: Soviet Physics—Solid State (USA).

20244 SPIN—LATTICE RELAXATION OF LOCAL ELECTRON CENTRES IN NON-METALLIC CRYSTALS.

M.F.Deigen and V.Ya.Zevin.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1126-37 (Oct., 1960). In Russian.

A theory is developed for the spin—lattice relaxation in strong magnetic fields. Hyperfine contact interaction between the localized electron and the nuclei on the lattice is considered as the relaxation mechanism. The general theory is developed in greater detail for crystals in which the wave-function of the localized electron may be written in the atomic-orbital approximation. As an example, the F-centre in a KCl-type crystal is discussed. A numerical calculation carried out for a KCl crystal yields a paramagnetic relaxation time of the order of several minutes at T = 4°K and H ≅ 3000 Oe. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 4, 785-92 (April, 1961)].

20245 SPIN—LATTICE RELAXATION OF LOCALIZED ELECTRONS (COMBINATION SCATTERING ACOUSTIC PHONONS). V.Ya.Zevin.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 599-606 (Feb., 1961). In Russian.

The authors consider spin—lattice relaxation due to combination scattering of acoustic phonons for a magnetic hyperfine interaction of the spin of a localized electron with the spins of the surrounding nuclei in a strong magnetic field. The temperature dependence of the transition probability is derived for $T \ll \theta$ and for $T > \theta$ (θ is the Debye temperature of the crystal) and is found to be independent of the magnetic field. F-centres in KCl are considered and it is shown that relaxation due to combination scattering of acoustic phonons becomes more effective than single-phonon relaxation at $T \cong 10°K$. At room temperature the spin—lattice relaxation time of F-centres in KCl is $\cong 10^{-5}$ sec. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 439-44 (Aug., 1961)].
M.G.Priestley

20246 A POSSIBILITY OF REALIZING ZERO-FIELD RESONANCE IN MANY-LEVEL SYSTEMS.

M.F.Deigen and A.B.Roitsin.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2876-8 (Sept., 1961). In Russian.

The possibility is discussed of obtaining maser action using transitions among the hyperfine structure levels of electrons at impurity centres in semiconductors. The special case of a homonuclear diatomic quasimolecule with nuclear spin $\frac{1}{2}$ (e.g. P in Si) and spin Hamiltonian $A(S_1I_1 + S_2I_2) + B(S_1S_2)$ is worked out in detail and one out of four levels picked out with two allowed transitions overlapping for sufficient separation of the impurity nuclei. The chance of observing actual amplification depends sharply on the distribution of the impurity atoms. [English translation in: Soviet Physics—Solid State (USA)].
G.Wyllie

20247 THE POLARIZATION OF NUCLEI BY THE "EFFET SOLIDE" METHOD AND THE RELAXATION OF NUCLEAR SPINS DURING RAPID PASSAGE THROUGH A FIELD.

J.Burget and M.Odehnal.
Czech. J. Phys., Vol. 10, No. 9, 645-9 (1960).

A description is given of one effect observed during the dynamic polarization of protons by the "effet solide" method and its theoretical explanation is proposed. With alternating modulation of the magnetic field not only did polarization at a resonance value of the field corresponding to the peak of the electron and nuclear resonance curve, which according to theory should not occur in such points, but there was also a change in its sign as a function of the direction of the passage through the field. This effect is explained by the "inertia" of the polarization during passage through a field in a time shorter than the spin-lattice relaxation time of the polarized nucleus.

20248 DYNAMIC POLARIZATION OF NUCLEI BY "SOLID EFFECT".

M.Borghini.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 664-6 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A dynamic method for the polarization of solids by application of a magnetic field and a radiofrequency field at low temperatures is theoretically discussed. Results obtained on samples of polystyrene, lithium fluoride, and $La_2Mg_3(NO_3)_{12}.24H_2O$ monocrystals are mentioned. G.I.W.Llewelyn

20249 DEFORMATION MODES OF A BLOCH WALL.

P.G.de Gennes and F.Hartmann-Boutron.
C.R. Acad. Sci. (France), Vol. 253, No. 16, 1662-4 (Oct. 16, 1961).
In French.

Calculates the characteristic frequencies corresponding to long-wavelength deformations of a Bloch wall, and the contribution of these modes to the nuclear relaxation. E.P.Wohlfarth

20250 CALCULATION OF THE SECOND MOMENT OF A NUCLEAR MAGNETIC RESONANCE LINE FOR A ROTATING GROUP PRESENT IN A MOLECULE.

V.V.Moskalev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3046-9 (Oct., 1961).
In Russian.

A formula of Van Vleck (Abstr. 949 of 1949), for the geometrical part of the dipole—dipole interaction in a group of similar nuclei capable of taking up a number of configurations, is brought into a convenient form, and some useful numerical coefficients worked out for the case of reorientation by rotation about a fixed axis. The general expression is in terms of elliptic integrals of the first and second kind. Numerical results are shown graphically and in a very short table. [English translation in: Soviet Physics—Solid State (USA)]. G.Wyllie

20251 SPIN ABSORPTION OF SOLIDS.

H.Cheng.
Phys. Rev. (USA), Vol. 124, No. 5, 1359-67 (Dec. 1, 1961).

A study of the spin absorption lines of all orders is made. Rules for obtaining the absorption operator of any line are found. With magnetic dipole—dipole and exchange interactions taken into account, and with the assumption that the Zeeman energy is dominant, the zeroth and the second moments of the following four lines are evaluated for powders: (1) first Larmor line, parallel field, (2) second Larmor line, parallel field, (3) second Larmor line, perpendicular field, (4) low-frequency line, perpendicular field. The contribution of exchange to the second moment is found to be the same for the four cases treated, while the total intensity has the ratio $1 : 1 : 1 : \frac{3}{2}$. Agreement with existing experimental data is good.

20252 CALCULATION OF THE CRYSTAL FIELD SPLITTING.

R.G.Shulman and S.Sugano.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 157-9 (Sept. 1, 1961).

The calculation is made with the aid of wave-functions determined by n.m.r. measurements (Abstr. 18227 of 1960) using the method of Tanabe and Sugano (Abstr. 8668 of 1956). The result for $10\ Dq = 5300\ cm^{-1}$ agrees reasonably well with the observed value of $7250\ cm^{-1}$. D.J.Oliver

20253 THEORY OF NUCLEAR MAGNETIC RESONANCE.

M.Mugur.
Stud. Cercetari Fiz. (Roumania), Vol. 8, No. 2, 171-213 (1957).
In Roumanian.

20254 ANALYSIS OF THE N.M.R. SPECTRA OF ACRYLIC ACID AND ETHYL ACRYLATE.

Y.Arata, H.Shimizu and S.Fujiwara.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2119 (Nov., 1960).

Values of chemical shifts and spin—spin coupling constants o acrylic acid and ethyl acrylate deduced from the NMR spectra are briefly discussed. G.I.W.Llewel

20255 NUCLEAR MAGNETIC RESONANCE IN $CuF_2 \cdot 2H_2O$ SINGLE CRYSTALS.

R.G.Shulman and B.J.Wyluda.
J. chem. Phys. (USA), Vol. 35, No. 4, 1498-9 (Oct., 1961).

The hydrogen and fluorine nuclear magnetic resonance signal were measured. The hyperfine interaction between the fluorine nucleus and the magnetic electrons was separated into isotropic a anisotropic components which were evaluated. The Néel temperat was determined to be 10.92° ± 9.2°K in contrast to the maximum i the susceptibility which was shown to occur at 26°K.

20256 N.M.R. OF Co^{59} IN FERROMAGNETIC HEXAGONAL COBALT METAL.

Y.Kôi, A.Tsujimura and T.Kushid
J. Phys. Soc. Japan, Vol. 15, No. 11, 2100 (Nov., 1960).

A weak signal with a maximum intensity at 230°C, the temper ture at which the anistropy constant Kui changes sign, was observed. The effective field at the nucleus, deduced from extrapolation of the NMR frequency to 0°K is $228.4 \pm 0.5 \times 10^3$ Oe. Thi is 11×10^3 Oe larger than that determined from low temperature specific heat measurements. A.J.Manu

20257 N.M.R. OF Co^{59} IN FERROMAGNETIC COBALT ALLOYS.

Y.Kôi, A.Tsujimura, T.Hihara and T.Kushida.
J. Phys. Soc. Japan, Vol. 16, No. 3, 574 (March, 1961).

The Co^{59} resonance in alloys of cobalt with a few per cent of iron, nickel, copper, aluminium, manganese or chromium, shows a structure presumably due to the spread of internal magnetic field at nuclear sites near to solute atoms. E.F.W.Seymou

20258 SPIN ECHOES OF Co^{59} IN F.C.C. COBALT METAL.

K.Sugibuchi, M.Matsuura and T.Hashi.
J. Phys. Soc. Japan, Vol. 16, No. 8, 1648 (Aug., 1961).

The spin relaxation time T_1 was measured between 77° and 300°K, with the results $T_1(77^\circ K) = 300 \pm 30\,\mu sec$ and $T_1(300^\circ K) = 85 \pm 10\,\mu sec$. This does not agree with previous work by Gossar and Portis (Abstr. 12501 of 1959). D.J.Olive

20259 NUCLEAR RESONANCE STUDY OF ELECTRONIC MAGNETISM IN COPPER—NICKEL.

D.L.Weinberg and N.Bloembergen.
J. Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 240-8 (Oct., 1960).

Alloying with 27, 38 or 43% nickel is found to produce extreme broadening and asymmetry of the n.m.r. of copper. Almost every observable copper nucleus appears to undergo a decrease in magnetic field. The width between derivative peaks is increased by as much as twelve times. It is satisfactorily proportional to or independent of applied field, according as electronic paramagnetism (in the 27% alloy) or weak ferromagnetism is expected to be involve but the central portion of the line expands in proportion to the field. The concentration dependences are much slower than that of the macroscopic magnetization. Isotropic indirect exchange coupling between the copper nuclei and the time average magnetic moments of the nickel atoms, and inhomogeneity of the Knight shift account for the measurements approximately. It is necessary to include large contributions from copper nuclei in noncubic environments. The field and concentration dependences are interpreted in terms of inhomogeneous electronic magnetism in the ferromagnetic alloys. The nickel paramagnetism cannot be identified in alloys of up to 15% nickel because of quadrupole effects.

20260 NUCLEAR MAGNETIC RESONANCE INTENSITIES IN ALLOYS.

D.L.Weinberg.
J. Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 249-60 (Oct., 1960).

The steady-state magnetic resonances of Cu^{63}, Al^{27} and Li^7 were studied in the majority constituents of the Cu—Ni, Cu—Au, Al—Zn and Li—Mg alloy systems, over wide ranges of composition, magnetic field and temperature. Nuclear electric quadrupole effects are most prominent. The linewidths, shapes and frequencies can be qualitatively understood in simple cases, but the predictions of the general statistical problem have not been obtained. Initial intensity reductions in copper alloys are consistent with screening of excess charge by conduction electrons and enhancement by ar hielding factors. The field gradients seem to be primarily of ch ge origin when there is a valence difference, but those arising fr size differences can be comparable. The intensity falls m kedly less rapidly above about 20% solute in Cu—Ni and Cu—Au, ar ncreases very strongly at about 40% Ni. The anomalous in sity is believed to arise from non-cubic configurations of so te atoms which give rise to small field gradients at the central n eus. The influence of order in Cu—Au on the intensity is d ribed better by the conventional long-range order than short-r ge order, because the former distinguishes between the Cu and A ub-lattices. The predictions are compared with effects of heat t tments.

261 F^{19} NUCLEAR MAGNETIC RESONANCE IN POLYCRYSTALLINE MgF_2.

.Ghosh, J.Lahiri and S.K.Sinha.
an J. Phys., Vol. 35, No. 5, 236-9 (May, 1961).

The second moment of the recorded line-shape was compared h that computed from the known lattice structure of MgF_2 crystal given by X-ray diffraction studies. The agreement is satis- tory.

0262 ELECTRICALLY INDUCED SHIFT OF THE F^{19} RESONANCE FREQUENCY IN MnF_2.

.Pershan and N.Bloembergen.
ys. Rev. Letters (USA), Vol. 7, No. 5, 165-7 (Sept. 1, 1961).

The shift theoretically prediced (Abstr. 14823 of 1961) was served, amounting to $\Delta\nu_E = 5$ kc/s for each of the four F^{19} nuclei the unit cell, if $E = 10^4$ V cm^{-1} is applied in the [100] direction. is is an order of magnitude smaller than the theoretical estimate d various reasons for the discrepancy are given. A possible plication to the investigation of antiferromagnetic domain walls is scussed. D.J.Oliver

INVESTIGATION OF REORIENTATION OF THE GUANIDINIUM N IN THE FERROELECTRIC $C(NH_2)_3.Al(SO_4)_2.6H_2O$ BY THE CLEAR MAGNETIC RESONANCE METHOD. See Abstr. 19923

20263 THE INFLUENCE OF THE DIPOLAR FIELD ON THE NUCLEAR RESONANCE OF Fe^{57} IN YTTRIUM IRON ARNET.

F.Boutron and C.Robert.
.R. Acad. Sci. (France), Vol. 253, No. 3, 433-5 (July 17, 1961).
French.

The effect of the magnetic dipolar field on the nuclear resonance frequency for different directions of magnetization, for oth uniform and non-uniform magnetization is discussed theoretic- lly, and the results compared with experiment. A.J.Manuel

20264 NUCLEAR MAGNETIC RESONANCE IN METALLIC POTASSIUM.

M.P.Klein and W.D.Knight.
. Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 355-6 (Oct., 1960).

The observation was made in a field of 13 000 Oe at 2.58 Mc/s, the line width being 0.7 kc/s. The Knight shift was $\Delta H/H = 0.261 \pm 0.002\%$ relative to KCl. From this result a value for the ratio of the probability density of the wave-function in the atom to that in the metal was derived: $P_F/P_A = 0.905$, compared with P_F/P_A (theor.) = 0.82. D.J.Oliver

20265 FINE STRUCTURE IN THE PROTON MAGNETIC RESONANCE SPECTRUM OF 6-6 NYLON.

D.J.Shaw and B.A.Dunell.
Canad. J. Chem., Vol. 39, No. 5, 1154-8 (May, 1961).

Broad line and high resolution n.m.r. studies are reported on a multifilament commercial 6-6 nylon yarn containing no delustrant. The broad line spectrum was taken at 28 Mc/s over the temperature range 77°K to 400°K and was similar to that reported by Slichter (Abstr. 9803 of 1955), showing no fine structure. Evidence of fine structure was also sought at room temperature, using a sample is equilibrium with a number of different partial pressures of water vapour. The fine structure obtained under these conditions disappeared when a deuterated sample was used in D_2O vapour. Samples dried by heating at 100°C under vacuum were used on the high-resolution instrument at 40 Mc/s. No fine structure was shown at room temperature but started to appear at 380°K and increased in intensity as the temperature rose. A resolution into broad and narrow components was possible, though with considerable error. The narrow component is attributed to the onset of very extensive molecular motion in part of the amorphous region, and is correlated with the α' dispersion region in the mechanical spectrum [Kolloid Zeitschrift (Germany), Vol. 134, 149 (1953)]. The effect of the physical state of the sample is discussed. R.G.C.Arridge

20266 ESTIMATION OF THE EFFECT OF SURFACE ON THE DIPOLAR BROADENING OF MAGNETIC RESONANCE LINES IN CRYSTALS.

G.C.Benson and P.Balk.
Canad. J. Phys., Vol. 39, No. 7, 1071-3 (July, 1961).

The second moment of the line width in NaCl crystalline powders is calculated, allowing for lattice distortion in the surface region. It is concluded that if any surface effect is observed in cubic crystals it must be due to interactions of other than a dipolar character. R.G.C.Arridge

20267 NUCLEAR MAGNETIC RESONANCE STUDY OF NaCl CRYSTAL CONTAINING Ca IMPURITIES.

J.Itoh, M.Satoh and A.Hiraki.
J. Phys. Soc. Japan, Vol. 16, No. 2, 343-4 (Feb., 1961).

Describes measurements of T_1 as a function of temperature. At first, T_1^{-1} increases, and reaches a maximum at 580°K due to the motion of isolated positive ion vacancies. A second peak is observed at about 810°K due to the motion of Ca^{++} ions. Above 900°K, T_1^{-1} increases sharply probably due to thermal vacancies. D.J.Oliver

20268 NUCLEAR RESONANCE OF Sn^{119} IN METALLIC TIN.

Yu.S.Karimov and I.F.Shchegolyev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 5, 1289-92 (May, 1961).
In Russian.

The dependence of the second moment of the absorption line of Sn^{119} on the external magnetic field strength was measured between 900 and 5800 Oe in metallic tin. A value of $\delta = 1.0 \times 10^{-3}$ was obtained for the Knight-shift anisotropy. The indirect exchange coupling constant between neighbouring nuclei in the metal was determined: A = 2.5 kc/s. [English translation in: Soviet Physics—JETP (USA)].

20269 THE SPLITTING OF THE NUCLEAR MAGNETIC RESONANCE LINES IN VIVIANITE.

W.van der Lugt and N.J.Poulis.
Physica (Netherlands), Vol. 27, No. 8, 733-50 (Aug., 1961).

The splitting of the nuclear magnetic resonance lines of vivianite $[Fe_3(PO_4)_2.8H_2O]$ was studied at temperatures of liquid nitrogen, liquid hydrogen and liquid helium. At a temperature between 4°K and 12°K the crystal becomes antiferromagnetic. Resonance diagrams with H_0 rotating in the ac-plane and in a plane perpendicular to the c-axis were determined at temperatures above as well as below the Néel temperature. In the antiferromagnetic state the internal magnetic fields at the positions of the nuclei were determined from measurements at constant resonance frequency and from zero external field measurements. Conditions for the antiferromagnetic spin arrangement of Fe^{2+} spins were derived from the symmetry properties of the internal field vectors. Two types of temperature dependences of the magnetization were found in the paramagnetic as well as in the antiferromagnetic state. They correspond to two systems of Fe^{2+} ions occupying different types of lattice sites. The resonance lines of the P nuclei exhibit a shift due to electron transfer from the Fe^{2+} ions to the phosphate groups.

20270 PROTON RESONANCE IN ACTIVATED CARBON AT SEVERAL TEMPERATURES.

R.Becherer.
Arch.Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 402-5 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The proton-resonance line width was investigated as a function of temperature at 30 and 60 Mc/s. Above 70°K the line width increases with decreasing temperature due to Ho/T variation of the local field. Below 70°K the line width decreases with decreasing temperature indicating a decrease in coupling between the proton and electronic spins, perhaps due to a change of molecular structure of the carbon. C.J.Ultee

20271 PROTON MAGNETIC RESONANCE IN FERROELECTRIC $(CH_3NH_3)AlSO_4.12H_2O$.

R.Hoshino.
J. Phys. Soc. Japan, Vol. 16, No. 4, 835-6 (April, 1961).

The appearance of a sharp central peak in the resonance line at about 160°K (i.e. about 16°K below the ferroelectric Curie point) is attributed to the onset of rotation of the methylammonium groups. A connection between the rotation and the disappearance of ferroelectricity is inferred. E.F.W.Seymour

20272 PROTON RESONANCE AND SPIN QUENCHING EFFECT IN $NiSO_4.7H_2O$.

H.Nagasawa and Y.Tomono.

J. Phys. Soc. Japan, Vol. 16, No. 1, 123 (Jan., 1961).

Field dependence of the second moment of the proton resonance line shape was observed in powdered $NiSO_4.7H_2O$ at room temperature. The square root of the second moment was found not to be exactly proportional to $H_0^2 + H_1^2$. The internal field, as deduced from this method, is about ten times higher than expected. F.Bruin

20273 DYNAMIC POLARIZATION IN LOW FIELDS OF PROTONS IN PARADICHLOROBENZENE.

A.Landesman.

J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 210-14 (Feb., 1961).
In French.

Using d.c. magnetic fields from 10-40 G the author studied dynamic polarization of protons by the "solid state effect" in paradichlorobenzene. Advantage was taken of the large quadrupole splitting of the chlorines. The expected enhancement of the magnetization of protons occurs when irradiated by r.f. magnetic field at the right frequency. Transition probabilities are calculated and measured as a function of r.f. power and d.c. field.

20274 PROTON MAGNETIC RESONANCE STUDY OF FERROELECTRIC POTASSIUM FERROCYANIDE TRIHYDRATE.

R.Blinc, M.Brenman and J.S.Waugh.

J. chem. Phys. (USA), Vol. 35, No. 5, 1770-5 (Nov., 1961).

Proton magnetic resonance and vibrational spectra of potassium ferrocyanide trihydrate were studied between 77° and 300°K. From the observed two sets of O—H stretching frequencies it has been possible to suggest the probable positions of four previously undetermined water molecules in the unit cell. Changes in the vibrational spectra and in the proton resonance second moment in the neighbourhood of the Curie point indicate that the onset of ferroelectric behaviour is associated with a dynamical orientational ordering of the hydrogen-bonded water molecules. Apparently there is also a contribution to the spontaneous polarization and internal field from displacements and polarizability of the K^+ and $Fe(CN)_6^{-4}$ ions.

20275 PROTON MAGNETIC RESONANCE IN POTASSIUM ACETATE.

M.Yagi and Y.Ishikawa.

Sci. Rep. Tohoku Univ. First Ser. (Japan), Vol. 43, No. 3, 148-51 (Oct., 1959).

The proton magnetic resonance of powdered potassium acetate was studied. Both the shape of a nearly bell type and the observed second moment of 10.3 G^2 at -175°C indicate that the methyl groups reorient about the C_3 axis. The maximum slope width decreases from 3.8 G to 3.3 G in the temperature range from -175° to 296°C near the melting point. The second moment also decreases appreciably at higher temperatures. These facts are presumably due to over-all free rotation and an additional motion of the methyl group, or due to a rapid motion existing partially in the sample.

20276 PROTON MAGNETIC RESONANCE OF SOLID SHORT-CHAIN MONOCARBOXYLIC ACIDS. II. TRICHLOROACETIC AND MONOCHLOROACETIC ACIDS.

M.Yagi.

Sci. Rep. Tohoku Univ. First Ser. (Japan), Vol. 43, No. 3, 131-6 (Oct., 1959).

For Pt I see 18231 of 1960. The crystal structures of monocarboxylic acids of short-chain radical are not well known, except for formic acid. From the proton magnetic resonance of solid trichloroacetic acid, it is concluded that the molecules in the lattice are arranged with the dimer form of two bridged protons. The resonance absorption observed on solid monochloroacetic acid indicates that the molecules at room temperature near the melting point are mostly in an effectively stationary state. The line shape varies easily with the state of the hydrogen bond. However, the existence of forms of the dimer of monochloroacetic acid in the solid state could not be distinctly confirmed by the proton magnetic resonance.

20277 NUCLEAR QUADRUPOLE RESONANCE IN IRRADIATED CRYSTALS.

J.Depireux, N.Cornet, M.Read and J.Duchesne.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 661-3 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Solid solutions of anthracene, naphthalene, 1,2,4,5-tetramethyl benzene, and 1,4-dimethylnaphthalene in p-dichlorobenzene were irradiated up to 10^8 rontgens using a Co^{60} source. The sensitivities of these compounds to radiation is discussed and briefly interpreted.

G.I.W.Llewel

20278 NUCLEAR QUADRUPOLE COUPLING CONSTANT O Be^9 IN BeO.

J.F.Hon.

Phys. Rev. (USA), Vol. 124, No. 5, 1368-72 (Dec. 1, 1961).

From the splitting of the nuclear magnetic resonance line in polycrystalline BeO, the quadrupole coupling constant of Be^9 in BeO was determined to be 41 ± 4 kc/s with zero asymmetry parameter. The effects of anisotropic distribution of crystallites were observed and used in the analysis of the data.

20279 ZEEMAN EFFECT OF THE NUCLEAR QUADRUPOLE RESONANCE SPECTRUM IN CRYSTALLINE POWDER

Y.Morino and M.Toyama.

J. chem. Phys. (USA), Vol. 35, No. 4, 1289-96 (Oct., 1961).

The Zeeman effect of the nuclear quadrupole resonance spectrum for spin $I = \frac{3}{2}$ in crystalline powder is studied. Theoretic considerations have predicted that, in a nonaxial electric field gradient, the absorption line should be broadened with a characteristic envelope by a weak static magnetic field. When a radiofrequency field is applied parallel to the static field, one pair of sharp minima should be produced on the envelope at the frequencie shifted by $\pm\gamma H\ 2\pi$ from the unperturbed quadrupole resonance line, and two pairs of sharp maxima at $\pm(1-\eta)\gamma H/2\pi$ and at $\pm(1-\eta)\gamma H/2\pi$. Resonance spectra of Cl^{35} nuclei in p-dichlorobenzene and cyanuryl chloride have clearly displayed the predicted shape of envelopes on a recorder at room temperature. Analysis of them resulted in determining the asymmetry parameters of electric fiel gradients with considerable accuracy; $0.07_0 \pm 0.01$ for the α-modification of p-dichlorobenzene, and 0.22 ± 0.03 for ν_1 line, and 0.23 ± 0.04 for ν_2 line of cyanuryl chloride.

20280 QUADRUPOLE COUPLING IN LITHIUM NITRATE.

D.H.Anderson.

J. chem. Phys. (USA), Vol. 35, No. 4, 1353-7 (Oct., 1961).

The value of the Li^7 quadrupole coupling constant in a single crystal of $LiNO_3$ has been found to be 35.5 ± 0.2 kc. It is expected that a reliable estimate of the quadrupole moment of Li^7 may be made with the observed coupling constant and the point-charge field gradient, because of the good agreement for Na^{23} in the case of the isomorphous crystal $NaNO_3$. The value found in this manner is ±0.069 b. The $LiNO_3$ crystal was γ irradiated to facilitate the measurements, and a γ-irradiated crystal of $NaNO_3$ was studied for comparison. It appears that the broadening of the Na^{23} satellite lines in the irradiated $NaNO_3$ results from a relaxation process an not from a wide distribution of static field gradients, and it is concluded that γ irradiation has little or no effect on the Li^7 coupli constant in $LiNO_3$. A precise knowledge of the Li^7 quadrupole moment would provide a test of the ionic model in $LiNO_3$.

20281 NUCLEAR QUADRUPOLE RESONANCE STUDIES OF SOLID SOLUTIONS OF SOME ORGANIC COMPOUNDS.

É.I.Fedin and A.I.Kitaigorodskii.

Kristallografiya (USSR), Vol. 6, No. 3, 406-12 (May-June, 1961).
In Russian.

Nuclear quadrupole resonance spectra were recorded for substitutional solid solutions of organic compounds in p-dichlorobenze It is found that the signal may vary in amplitude as a function of co centration in one of three ways; the signal is also dependent on the mechanical and heat treatment of the material. The effects of the minor component on the signal are dependent on the ratio of the molecular sizes of the two components. Deductions are made abou the size and structure of the distorted region around a molecule of the minor component. [English translation in: Soviet Physics—Crystallography (USA), Vol. 6, No. 3, 322-5 (Nov.-Dec., 1961)].

MECHANICAL PROPERTIES OF SOLIDS

)282 THE MEASUREMENT, BY MEANS OF POLARIZED ULTRASONIC WAVES, OF THE VARIATION OF THE E STIC CONSTANTS OF A SOLID SUBJECTED TO STRESS.
R ıcas and S.Pauthier-Camier.
C Acad. Sci. (France), Vol. 252, No. 25, 3937-9 (June 19, 1961).
In rench.

The method uses polarized, transversal, ultrasonic waves, and a ıntages are claimed for this method of studying the variation of el tic constants with stress as compared with the measurement of th velocity of longitudinal waves. The specimens are 25 × 25 × 2 mm long, and are subjected to stress over a section o 20 × 25 mm^2. The transverse waves are generated by a quartz tı sducer at 2.4 Mc/s at one end of the specimen and detected at th other. The strength of the received signal depends upon the a ıe between the electrical axes of transmitter and receiver, and th variations of elastic properties with orientation are determined b he difference between the theoretical curve relating received s ıal to this angle and that which is actually obtained experimentally. T paper gives an outline of the theory of the technique and a few r ults obtained with glass specimens. A.C.Whiffin

20283 INSTRUMENT FOR THE CONTINUOUS DETERMINATION OF THE MECHANICAL INTERNAL ENERGY SSES IN HIGH-POLYMER SOLIDS OVER A WIDE RANGE OF MPERATURE AND FREQUENCY. P.Lord and R.E.Wetton.
sci. Instrum. (GB), Vol. 38, No. 10, 385-9 (Oct., 1961).

An instrument has been developed for the continuous measure- nt of the dynamic modulus and the mechanical loss factor of h-polymer solids, over the frequency range 0.5 c/s to 2 kc/s, l at temperatures between −100° C and +140° C. The phase and plitude of torsional oscillation of an electromagnetically driven ecimen are measured with the aid of a capacitance transducer. e temperature is controlled by an adiabatic vacuum system.

20284 ELASTIC CONSTANTS OF CRYSTALS BY WEDGE METHOD—ELECTRICAL DETECTION OF SONANT FREQUENCIES.
Krishna Murty and B.Subrahmanyam.
sci. industr. Res. (India), Vol. 20 B, No. 9, 448-9 (Sept., 1961).

Elastic constants of the cubic crystals, lead nitrate, strontium trate and zinc sulphide were determined. The grid current of the citing oscillator was found to exhibit a dip when the specimen brated at its resonant frequency. It is confirmed that these dips cur exactly where the diffraction maxima occur. The elastic nstants determined by this method agree quite satisfactorily with ose determined by optical detection in the wedge method. The ethod described does not require the use of any liquid and hence s the advantage of being useful for temperature studies in ela- ity.

20285 INSTRUMENT FOR THE MEASUREMENT OF ELASTIC HYSTERESIS IN TORSION.
..Diamond and J.E.Whittle.
sci. Instrum. (GB), Vol. 38, No. 11, 420-3 (Nov., 1961).

Describes an instrument capable of measuring the elastic ysteresis of a rod specimen in torsion under static conditions, hen the hysteresis strain is only a few parts in 10^4 of the maximum train. An interferometric strain gauge is employed with specimens pproximately 9 in. long × $\frac{1}{8}$ in. diameter.

20286 A DEMOUNTABLE INDUCTIVE STRAIN GAUGE. G.C.Reynolds.
ag. Concrete Res. (GB), Vol. 13, 77-8 (July, 1961).

The paper describes a demountable strain gauge, with a gauge ength of 50 mm, or just under two inches, suitable for measuring trains of 10^{-5}.

20287 FORMULATION OF A THEORY OF ELASTICITY. D.D.Ivlev.
okl. Akad. Nauk SSSR, Vol. 138, No. 6, 1321-4 (June 21, 1961).
n Russian.

For abstract, see Abstr. 14844 of 1961. [English translation in: oviet Physics—Doklady (USA), Vol. 6, No. 6, 519-21 (Dec., 1961)].

20288 ON A CERTAIN FORM OF SOLUTION OF EQUATIONS OF STATIC ELASTICITY THEORY. J.Golecki.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 9, No. 3, 139-43 (1961).

Results are applicable to incompressible isotropic elastic solids, which formally constitute a peculiar case of compressible solids with the Poisson ratio ν satisfying the inequality $0 \leq \nu \leq 0.5$; the mass forces are disregarded. The formulae obtained are also valid for solids whose geometric structure forms multi-connected regions, if additional conditions (stated) are satisfied.
J.K.Skwirzynski

20289 THE ATOMISTIC AND THE CONTINUUM THEORIES OF CRYSTAL ELASTICITY.
R.S.Krishnan and E.S.Rajagopal.
Ann. Phys. (Germany), Vol. 8, No. 3-4, 121-36 (1961).

The lattice theory of crystal elasticity is developed with special reference to the basic postulates of the lattice models, the role of initial stresses and the validity of the rotational invariance condition. The elastic behaviour of the infinite lattice is investigated theoretically by the method of homogeneous deformation and by the method of long waves. The exact generalization of the classical theory, viz. the existence of surface couples, is deduced from these considerations. It is also proved that the presence of volume couples does not alter the structure of the classical theory. A complete correspondence between the lattice and the continuum approaches is exhibited. Some subtle considerations, regarding the extension of the continuum concepts of strains and stresses to atomic lattices, and the clear distinction between the initial stress and the natural stress problems are also pointed out.

20290 ON SIX NEW RELATIONS BETWEEN THE ELASTIC CONSTANTS OF CRYSTALS. N.Joel and W.A.Wooster.
Acta cryst. (Internat.), Vol. 14, Pt 6, 571-8 (June, 1961).

It is shown that in those cases where Laval's scheme of 45 elastic constants is applicable, there are six relations that must be satisfied by the elastic constants. These relations follow from an analysis of the body-couples and of the strain-energy function. As a consequence the number of independent elastic constants of a triclinic crystal is reduced from 45 to 39; reductions also take place in the other crystal classes. The new elastic matrices are given for each of the eleven Laue-groups and for isotropic solids. There is also a discussion on the various assumptions that have been made by different authors regarding the rotational invariance of the strain energy.

20291 NEW MEASUREMENTS OF THE ELASTIC CONSTANTS OF A.D.P. AND THEIR RELATION TO THE THEORIES OF CRYSTAL ELASTICITY. N.Joel and W.A.Wooster.
Acta cryst. (Internat.), Vol. 13, Pt 7, 516-25 (July, 1960).

Some of the adiabatic elastic constants of ADP were remeasured by means of Bergmann—Schaefer elastograms. The chief aim was to obtain the best possible value of the ratio c_{44}/c_{55} in order to establish whether ADP agreed or not with the classical theory of crystal elasticity. The elastograms were measured not only along two principal axes and along the 45° direction, as has been customary so far, but also in many directions in the same plane. These measurements were used for determined the c_{ij} by means of least-squares methods. The results are:

$$c_{11} = 66.9,\ c_{33} = 32.8,\ c_{13} = 19.9,\ c_{44} = 8.8,\ c_{55} = 8.3 \times 10^{10}\ \text{dyne cm}^{-2}.$$

The ratio c_{44}/c_{55} is 1.06 ± 0.02, thus confirming the validity of Laval's connection that 21 elastic constants are not in general sufficient for describing the elastic properties of crystals.

20292 ELASTIC CONSTANTS OF HEXAGONAL CADMIUM SULFIDE. D.I.Bolef, N.T.Melamed and M.Menes.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 143-8 (Dec., 1960).

The adiabatic elastic constants of a single crystal of hexagonal CdS were measured at 27°C. Measurements were made at 10 Mc/s by means of an ultrasonic c.w. mechanical resonance technique. The elastic stiffness constants, in units of 10^{11} dynes/cm^2, are: $c_{11} = 8.432$, $c_{33} = 9.397$, $c_{44} = 1.489$, $c_{12} = 5.212$, $c_{13} = 4.638$. Single-crystal CdS has very low anisotropy as indicated by the ratios $c_{11} - c_{12}/2c_{44} = 1.08$ and $c_{33}/c_{11} = 1.11$.

20293
ELASTIC PROPERTIES OF CsCl-TYPE CRYSTALS.
S.Haussühl.

Acta cryst. (Internat.), Vol. 13, Pt 9, 685-7 (Sept., 1960). In German.

The elastic and thermoelastic constants were measured for five crystals of the CsCl structure by ultrasonic methods. The results are compared with the elastic properties of alkali halides of the NaCl structure. Anomalous thermoelastic effects were observed for NH_4Br and NH_4Cl.

20294
ELASTIC CONSTANTS OF ORDERED AND DISORDERED Cu_3Au FROM 4.2 TO 300°K.
P.A.Flinn, G.M.McManus and J.A.Rayne.

J. Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 189-95 (Oct., 1960).

The room temperature data are in good agreement with previous work. At liquid helium temperatures the ordered material, with $S = 0.95$, gives $c_{11} = (1.893 \pm 0.015) \times 10^{12}$, $c_{12} = (1.319 \pm 0.015) \times 10^{12}$, $c_{44} = (0.736 \pm 0.002) \times 10^{12}$ dyn cm^{-2}. The corresponding value of Debye temperature is θ (ordered) = 283.8 ± 3.5°K, which compares very well with the calorimetric figure of 285 ± 2°K. For the disordered alloy, the elastic data give a Debye temperature of θ (disordered) = 281.6 ± 3.5°K, which is within experimental error of the calorimetric value of 278 ± 2°K. The elastic constants for the disordered alloy indicate that the Fermi surface is less distorted than that in pure copper.

GLASSES POSSESSING HIGH YOUNG'S MODULI.
See Abstr. 20635

20295
ELASTIC CONSTANTS OF INDIUM FROM 1.4° TO 300°K.
B.S.Chandrasekhar and J.A.Rayne.

Phys. Rev. (USA), Vol. 124, No. 4, 1011-14 (Nov. 15, 1961).

The adiabatic elastic constants were measured using the ultrasonic pulse technique. At 1.4°K no difference between the elastic constants in the superconducting and normal states was observed to within the available accuracy of about 1 part in 10^4. The bearing of this observation on the calorimetric data for indium below 1°K (Abstr. 13489 of 1960) is discussed. From the elastic constant data extrapolated to 0°K, the limiting value of the Debye temperature for indium is calculated to be 111.3°K, with an estimated uncertainty of 1%. An extremely large variation with temperature of the shear constant $(c_{11} - c_{12})/2$ is observed.

20296
LOW-TEMPERATURE ELASTIC CONSTANTS OF MAGNESIUM ALLOYS.
S.Eros and C.S.Smith.

Acta metallurgica (Internat.), Vol. 9, No. 1, 14-22 (Jan., 1961).

The elastic constants of a series of magnesium alloy single-crystals were measured at liquid nitrogen and liquid helium temperatures, as well as at 25°C. These alloys covered an electron/atom range of 1.996-2.020. The purpose was to look for effects which are predicted to be associated with the initiation of a new electronic overlap, and which can only be observed at low temperatures. In particular, the onset of such an overlap should be manifested by a sudden drop in the observed values of $C = C_{11} + C_{12} + 2C_{33} - 4C_{13}$ at and beyond that value of e/a for which the overlap occurs. No such drop is observed in the range covered. This fact, and the directness and simplicity with which the rigid band model predicts such elastic behaviour, are considered strong evidence that no new overlap was initiated in the range investigated.

ELASTIC CONSTANTS OF NaCl-TYPE CRYSTALS.
See Abstr. 19690

20297
CORRECTED VALUES OF ELASTIC CONSTANTS OF SAPPHIRE.
W.G.Mayer and E.A.Hiedemann.

Acta cryst. (Internat.), Vol. 14, Pt 3, 323 (March 10, 1961).

20298
ON THE RELATION BETWEEN THE CHANGE IN MODULUS OF RIGIDITY OF BRASS WIRES BY COLD-ROLLING AND ROLLING TEXTURES.
J.Kuroyanagi.

J. Phys. Soc. Japan, Vol. 16, No. 5, 1019-23 (May, 1961).

Pole figures for the brass specimens which had been used for the measurement of the change in modulus of rigidity in the previous investigation (Abstr. 11517 of 1961) and had received 90% reduction in cross-sectional area by cold-rolling were obtained. In the pole figure of Cu, the most intense rolling texture was {112} ⟨111⟩. In the pole figure of brass containing 10.14% Zn, the most intense texture was {110} ⟨112⟩ and the {110} ⟨001⟩ texture also appeared in the figure in considerable degree. The intensity of the {110} ⟨001⟩ texture increases with the increase of Zn content. The existence of the β-phase in the brass wire containing 40.24% Zn was ascertained, which had been predicted in the previous paper. On the basis of these results the variation in the modulus of rigidity of the specime 57.5% cold-rolled, with various zinc contents was investigated.

20299
ELASTIC PROPERTIES OF CRYSTAL LATTICES OF WURTZITE STRUCTURE. I. EXPERIMENTAL INVESTIGATION OF HEXAGONAL CADMIUM SULPHIDE MONOCRYSTALS.
E.Gutsche.

Phys. Status solidi (Germany), Vol. 1, No. 1, 30-6 (1961). In Germ

Reports measurements of the linear compressibilities, and of the complete set of the five independent elastic constants, of hexagonal cadmium sulphide monocrystals. The measured quantities exhibit an approximate elastic isotropy and furnish a remarkable violation of the Cauchy relations.

20300
ELASTIC PROPERTIES OF CRYSTAL LATTICES OF WURTZITE STRUCTURE. II. ELASTIC BEHAVIOUR OF THE WURTZITE AND ZINC-BLENDE LATTICES IN A MODEL WITH CENTRAL FORCES BETWEEN NEAREST AND NEXT-NEAREST NEIGHBOURS.
E.Gutsche.

Phys. Status solidi (Germany), Vol. 1, No. 2, 147-59 (1961). In German.

Theoretical investigation. Expressions for the elastic constants, the compressibility, and the optical frequency limits are derived and compared with experiment. The zinc-blende lattice is treated in the same approximation. Analogies and symmetry-induced differences between the elastic behaviour of both structure are discussed.

20301
ATTEMPT TO INTERPRET THE INFLUENCE OF PRESSURE ON THE MODULUS OF RIGIDITY OF TWO GLASSES IRRADIATED BY NEUTRONS.
J.Paymal and C.Susse.

C.R. Acad. Sci. (France), Vol. 253, No. 11, 1196-8 (Sept. 11, 1961). In French.

The quantity β (the derivative of the modulus of rigidity with respect to pressure) was determined as a function of neutron dose (up to 4×10^{18} n/cm^2) for pyrex and for a lead glass. For pyrex, β increases with dose to a steady level, with an anomaly at about $0.1 - 0.2 \times 10^{18}$ n/cm^2. For lead glass there appears to be a maximum at about 0.3×10^{18} n/cm^2 after which the value of β falls to a steady level. The results are interpreted in terms of thermal and displacement spikes. J.Thewlis

20302
YOUNG'S MODULUS AND ITS VARIATION WITH MAGNETIZATION IN ANNEALED IRON—COBALT ALLOYS.
M.Yamamoto.

Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 4, 291-308 (Aug., 1960).

With annealed iron—cobalt alloys covering the whole composition range, Young's moduli and their changes with magnetization (the ΔE effect) in magnetic fields up to 900 Oe were measured at ordinary temperatures using the method of magnetostrictively excited longitudinal vibration. In this connection, the density and some ferromagnetic properties were also determined. It was found that the negative ΔE effect occurs at weak magnetic fields in most alloys excluding 45 to 50 and 100% Co. The absolute magnitude of the negative minimum of the ΔE effect is, at most, of the order of 0.1% in alloys containing less than 45% Co, while it amounts to more than 2% in alloys containing 65 to 70% Co. The maximum measured values of the ΔE effect, $(\Delta E/E_0)_{max}$, which are approximate to the saturation values, $(\Delta E/E_0)_S$, excepting only for pure cobalt, are all positive in the whole composition range of the alloys. The $(\Delta E/E_0)_{max}$ versus composition curve exhibits a very sharp and high peak of 22.10% at about 50% Co. The trend of the curve in the α (body-centred cubic) phase range agrees qualitatively very well and quantitatively fairly well with the results of calculation by a formula

$$(\Delta E/E_0)_S = (0.7\chi_0\lambda_S{}^2E_0/I_S{}^2)/(1 - 0.7\chi_0\lambda_S{}^2E_0/I_S{}^2),$$

where χ_0, λ_S, I_S, and E_0 are the initial magnetic susceptibility, saturation magnetostriction, saturation magnetization, and Young's modulus at unmagnetized state, respectively. The Young's modulus at unmagnetized state versus composition curve shows two maxima at about 25 to 30 and 60% Co and one minimum at about 50% Co in the α phase range, and then falls considerably up to its boundary (at about 80% Co). The modulus recovers in the $\alpha + \gamma$ phase range, but it decreases again in the narrow ϵ (hexagonal close-packed) phase range. The marked discrepancies found between the results of present dynamical measurements and those of the previous sta al measurements by Honda and Tanaka (1926) on the ΔE effect an oung's modulus at unmagnetized state are shown to be due to dif ences in purity and in treatments of the specimens as well as to ferences in the state of stress at the time of measurements of the pecimens. It is also shown that, with an addition of cobalt to ir the density increases approximately hyperbolically up to pure co t, except for a small discontinuity near 80% Co, and the initial m etic susceptibility exhibits a sharp maximum near 50% Co and a minimum at 65 to 75% Co.

0303 TEMPERATURE DEPENDENCE OF THE ELASTIC CONSTANTS OF SINGLE CRYSTAL LITHIUM F ORIDE.

Yu.M.Chernov and A.V.Stepanov.
Fi tverdogo Tela (USSR), Vol. 3, No. 9, 2872-4 (Sept., 1961).
In ussian.

Using a composite oscillator technique the Young's moduli and E_{110}, and the shear modulus G_{100} were measured as a func- of temperature from room temperature to 500°C. The compli- a s S_{11}, S_{12}, S_{44} are calculated from the results. [English trans- la n in: Soviet Physics–Solid State (USA)]. R.F.S.Hearmon

0304 ANOMALOUS ELASTICITY MODULUS AND DOMAIN STRUCTURE OF NICKEL.

.Molotilov and Yu.A.Osip'yan.
l. Akad. Nauk SSSR, Vol. 139, No. 5, 1095-7 (Aug. 11, 1961).
ussian.

Continuing earlier work (Abstr. 728 and 6292 of 1960), the gnetic structure of nickel specimens was examined in relation t rystal orientation and to the existence of slip lines in the cimen. [English translation in: Soviet Physics—Doklady (USA)]. R.F.S.Hearmon

20305 EFFECT OF COMPOSITION ON THE ELASTIC PROPERTIES OF BINARY NICKEL ALLOYS.

a.Beniyeva.
rayin. fiz. Zh. (USSR), Vol. 5, No. 2, 223-30 (1960). In Ukrainian.

Studies the effect of composition on the elastic properties of a nber of systems on a nickel base (Ni—Cr, Ni—Mo, Ni—Ti, Ni—Al). e coefficients of thermal expansion of the alloys investigated were ermined. It was found that on adding chromium or molybdenum nickel the modulus of elasticity increases, while on alloying with anium or aluminium the modulus of elasticity is only slightly ered. The Debye temperature for nickel—chromium, nickel—anium and nickel—aluminium alloys was determined by Young's dulus data. The Debye temperature, calculated from elasticity nstants, changes slightly on alloying. It was established that the tio of the temperature coefficient of thermal expansion to the mperature coefficient of the modulus of elasticity for nickel—lybdenum and nickel—titanium alloys is approximately constant a definite temperature region. Hence, the temperature coefficient the modulus of elasticity may be approximately determined from e thermal expansion coefficient of the alloy.

20306 CHANGE OF MECHANICAL CHARACTERISTICS OF AMORPHOUS SELENIUM UNDER THE ACTION OF AMMA RAYS.

V.Starodubtsev, I.A.Domoryad and L.P.Khiznichenko.
okl. Akad. Nauk SSSR, Vol. 139, No. 3, 594-5 (July 21, 1961).
Russian.

For abstract, see Abstr. 14849 of 1961. [English translation in: oviet Physics—Doklady (USA), Vol. 6, No. 7, 625-6 (Jan., 1962)].

20307 CHANGES OF ELASTIC MODULUS ASSOCIATED WITH INTERNAL FRICTION IN SODIUM CHLORIDE.

.W.Whitworth.
hil. Mag. (GB), Vol. 6, 1115-18 (Sept., 1961).

Previous measurements of the amplitude-dependent internal riction of NaCl at 90 kc/s and room temperature (Abstr. 21100 of 960) were extended to study the corresponding changes in Young's nodulus. It is concluded that the motion of dislocations giving rise o the amplitude-dependent damping lags in phase behind the stress y about 30° to 60°. Previously described changes in damping roduced by high amplitude vibration are associated with corres- ponding changes in the modulus defect.

20308 TEMPERATURE DEPENDENCE OF YOUNG'S MODULUS AND THE DAMPING DECREMENT OF NICHROME ALLOYS WITH ADMIXTURES OF TUNGSTEN OR MOLYBDENUM.

Z.L.Khodov and V.I.Il'chenko.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 235-41 (1960)
In Ukrainian.

The authors investigated the effect of molybdenum and tungsten admixtures on the Young's modulus and the internal friction of nichrome, and studied the temperature dependence of these quantities. It was found that for nickel—chromium—tungsten alloys, an increase in the tungsten concentration from 0.6 to 2.86 at.% leads to an increase in the modulus throughout the temperature range 20° to 800°C. The value of the damping decrement of these alloys changes very slightly from room temperature to 500-550°C. On further rise in temperature there is a very sharp increase in the decrement. Of the alloys investigated of the nickel—chromium—tungsten system, containing from 0.97 to 6.44 at.% of Mo, the alloy with 6.44 at.% of Mo had the least value of Young's modulus. The temperature dependence of the damping decrement of Ni—Co—Mo alloys is similar to that of Ni--Co—W alloys. The sharp rise in the value of the decrement, observed at a definite temperature for each alloy, is probably associated with viscous slipping along the grain boundaries. The dependence of the modulus on the molybdenum or tungsten concentration suggests that molybdenum and tungsten admixtures have a similar effect on nickel—chromium alloys, at any rate in the case of a slight admixture (up to 3 at.%). This is evidently due to the fact that these metals belong to the same subgroup of the Mendeleev system.

20309 MAGNETOMECHANICAL DAMPING IN CHROMIUM.

M.E.de Morton.
Phil. Mag. (GB), Vol. 6, 825-31 (July, 1961).

Damping hysteresis observed with changing temperature and strain-amplitude below ~ 40°C and a marked reduction of strain-amplitude-dependent damping in this region when a biasing tensile stress is present, is consistent with the suggestion that an anti-ferromagnetic domain structure exists in chromium below ~ 40°C.

20310 AN APPARATUS FOR MEASURING INTERNAL FRICTION IN SOLIDS OVER THE RANGE 20-400 kc/s.

A.V.Kharitonov.
Akust. Zh. (USSR), Vol. 7, No. 1, 104-6 (1961). In Russian.

The apparatus described is designed to investigate materials with low internal friction $Q^{-1} = 10^{-2}$ to 10^{-6}. Longitudinal oscillations of the sample are produced by means of the ponderomotive forces of a plate condenser formed by the face of the sample and an electrode placed from 0.05 to 0.1 mm from the face. The sample is mounted in the nodal plane by means of wires. The arrangement is placed in a vacuum. The attenuation decrement is measured by determining the width of the resonance curve or the rate of decay of free oscillations. Measurements are made by either an eddy current method (for non-ferromagnetic substances) or by using a barium titanate pick-up ring holding the mounting wires. Sample deformation amplitudes can be measured ranging from about 10^{-8} to 5×10^{-5}. Measurements in Al, Mg and Cu show only a slight frequency dependence of the internal friction and a very small value for this quantity. [English translation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 83-5 (July-Sept., 1961)]. W.G.Mayer

20312 STRESS INDUCED AMPLITUDE DEPENDENCE OF INTERNAL FRICTION IN Fe—Ni ALLOYS.

B.Rothenstein and J.Hrianca.
Czech. J. Phys., Vol. 10, No. 9, 684-5 (1960). In German.

An investigation of the internal friction in electrolytically deposited Fe—Ni alloys (21% Fe—79% Ni) shows a stress induced dependence of the friction on the amplitude of elastic oscillations. D.S.Parasnis

20311 CREATION OF HIGH TEMPERATURES BY INTERNAL FRICTION.

N.S.Fastov.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 5, 1069-72 (June 11, 1961).
In Russian.

For abstract, see Abstr. 14852 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 6, 508-11 (Dec., 1961)].

20313 ON THE INTERPRETATION OF INTERNAL FRICTION EXPERIMENTS ON STRAIN AGEING OF IRON.

J.C.Swartz.
J. appl. Phys. (USA), Vol. 32, No. 10, 2048 (Oct., 1961).

The logarithmic decrement of torsional vibrations in iron wires containing carbon was measured during strain ageing as a function of temperature. Analysis of the peak and background components provides no evidence of the dissolution of carbon atmospheres during deformation. R.F.S.Hearmon

THE EFFECT OF FATIGUE STRESSING ON THE DIFFUSION RATE OF ZINC IN ALUMINIUM. See Abstr. 19807

20314 THEORY AND APPLICATION OF A SUPERPOSITION MODEL OF INTERNAL FRICTION AND CREEP.

J.R.Macdonald.

J. appl. Phys. (USA), Vol. 32, No. 11, 2385-98 (Nov., 1961).

Energy dissipation in solids is important in both transient and steady-state measurements. The results of such measurements can be associated with a distribution of relaxation times provided the material is linear. In the present work, general relations are derived for the attenuation factor, phase factor, and specific dissipation function $1/Q$ pertaining to transmission of small-amplitude stress waves in a material describable by a distribution of relaxation times. Next, a specific, physically realizable relaxation-time distribution is used to obtain a creep function and to relate transient creep and frequency-response measurements. Curves of $1/Q$ versus frequency are calculated with a digital computer and show a region approximately proportional to frequency at sufficiently low relative frequencies, a region of virtual frequency-independence, and a final region proportional to inverse frequency at high relative frequency. The relation of the present work to other treatments of creep and internal friction is discussed, and the applicability is examined of the analytic and numeric results to creep measurements on metals and rocks, to low-frequency wave transmision in the earth, to other damping results for the earth as a whole, and to higher-frequency wave transmission and vibration results for geophysical and other solids. Good agreement between theory and experiment is found for frequency regions where adequate data are available, indicating that all the damping phenomena considered may be well described by a linear theory in the range of very small strain.

20315 PARAELASTICITY, A MECHANICAL ANALOG OF PARAMAGNETISM. W.Känzig.

Phys. Rev. Letters (USA), Vol. 7, No. 8, 304-6 (Oct. 15, 1961).

Reports on radicals (e.g. 0_2^-) substituted into alkali halides; these have special kinetic behaviour and can be aligned by small mechanical stresses. The orientational distribution can be accurately measured by means of paramagnetic resonance; the kinetics of the alignment process is studied by monitoring the intensity of paramagnetic resonance lines upon sudden application or removal of the stress. The system can be considered as a mechanical analogue of paramagnetism, not only with regard to its static behaviour, but also with regard to its relaxation behaviour at very low temperatures. J.K.Skwirzynski

20316 THE PHENOMENON OF "PHOTOINELASTICITY" IN AgCl. Yu.Kh.Vekilov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 545-6 (Feb., 1961). In Russian.

Measurement of the damping of torsional vibrations in annealed AgCl specimens at 1 c/s shows that irradiation by ultraviolet light decreases the damping by about 30%, but that the original value is recovered when irradiation ceases. The effect is due to migration of colour centres and dislocations. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 400 (Aug., 1961)]. R.F.S.Hearmon

20317 KINETICS OF FORMATION OF TOOTH-LIKE CURVES IN DEFORMATION GRAPHS. N.N.Davidenkov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2458-65 (Aug., 1961). In Russian.

Discontinuous deformations, occurring with iron and steel in the region of blue brittleness and with all metals in the range of liquid helium temperatures, are considered by means of the theory of relaxation self-oscillations, applied to the analysis of intermittent friction; the nature of these deformations is also discussed and it is shown that tooth-like time—deformation curves of metals can be completely described in terms of the analogous discontinuous friction phenomena. [English translation in: Soviet Physics—Solid State (USA)]. J.K.Skwirzynski

20318 STRESS RELAXATION IN ALPHA-IRON AT LOW TEMPERATURES. P.Feltham.

Phil. Mag. (GB), Vol. 6, 847-50 (July, 1961).

Relaxation of the applied tensile stress σ at strains of up to 2% was studied at 77-358° K in vacuum-annealed iron containing 0.1% of carbon. The relaxation was logarithmic, and the slopes of the curves,

$$s(T) \equiv -d\sigma/d(\log_{10} t),$$

increased from 19.7 kg/cm² at 358° K to 313 kg/cm² at 77° K. Th relation

$$Q_j[1 - (T/T_m)] = 2.3\ (kT/s)(\sigma_y - \sigma_g),$$

previously derived for stress relaxation in copper, in which T_m is the melting temperature, σ_y the tensile yield stress, and σ_g the temperature independent part of the yield stress, was again found to be applicable, with Q_j, the energy associated with the conservative migration of jogs in edge dislocations, equal to 6.4 kcal/g atom.

RELAXATION PHENOMENA IN GLASS. See Abstr. 20633

ANELASTIC RELAXATION IN ZrH_2. See Abstr. 14939

DISLOCATION RELAXATION IN SILVER, GOLD, PALLADIU AND PLATINUM. See Abstr. 17533

20319 DEPENDENCE OF THE COMPRESSION CURVE PARAMETERS OF SINGLE-CRYSTAL GERMANIUM ON TEMPERATURE AND STRAIN VELOCITY.

V.G.Govorkov and V.R.Regel'.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1324-30 (May, 1961). In Russian.

For abstract, see Abstr. 14864 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 958-63 (Nov., 1961)].

20320 ON THE TENSILE STRESS—STRAIN RELATION AND THE BAUSCHINGER EFFECT FOR POLYCRYSTALLI MATERIALS FROM TAYLOR'S MODEL.

S.J.Czyzak, N.Bow and H.Payne.

J. Mech. Phys. Solids (GB), Vol. 9, No. 1, 63-6 (Feb., 1961).

An extension of Taylor's theoretical model (1938) is used to investigate the behaviour of a polycrystalline material subjected to a fully plastic tensile strain first in one sense of displacement and then in the opposite sense. Some agreement with experimental results is obtained.

20321 COMPARISON OF STRESSES AND DISLOCATIONS IN GERMANIUM CRYSTAL.

V.I.Nikitenko and V.L.Indenbom.

Kristallografiya (USSR), Vol. 6, No. 3, 432-8 (May-June, 1961). In Russian.

The stress distribution in the cross-section of a germanium ingot was studied by the photoelastic method. The stress field in the entire ingot is re-established mathematically. The correspond ing temperature field is compared with the dislocation distribution [English translation in: Crystallography (USA), Vol. 6, No. 3, 341- (Nov.-Dec., 1961)].

20322 THE KINETICS OF THE INSTANTANEOUS ELASTIC DEFORMATION OF POLYMERS IN THE ELASTIC STATE. L.V.Ivanova, V.F.Chuvaev and P.A.Rebinder.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 83-6 (July 1, 1961). In Russian.

For abstract, see Abstr. 14871 of 1961. [English translation Soviet Physics—Doklady (USA), Vol. 6, No. 7, 616-18 (Jan., 1962)].

20323 MEASUREMENT OF RESIDUAL STRESSES IN ELECTROLYTIC COATINGS. N.N.Davidenkov.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2919-22 (Nov., 1960). In Russian.

When the moduli of elasticity of the cathode and coating are equal, Stoney's formula may be used with two corrections: for the variation of the moment of inertia of the cathode during deposition and for the flat stressed condition. When the moduli are different, the suggested formula has the form of an integral which can only be integrated numerically. F.Lachm

20324 ANNEALING BOULES OF SYNTHETIC CORUNDUM. R.P.Bashuk, E.G.Vol'pert and I.N.Tsigler.

Kristallografiya (USSR), Vol. 5, No. 4, 643 (July-Aug., 1960). In Russian.

Crystals of synthetic corundum grown by the Verneuil

i have high residual stesses, which often cause splitting
nly a slight mechanical shock. Partial relief of these
es has been observed by annealing, allowing the boule to
tioned into plates parallel and perpendicular to the optic
[English translation in: Soviet Physics—Crystallography
, Vol. 5, No. 4, 614 (Jan.-Feb., 1961)]. R.V.Coates

325 THE THERMODYNAMIC THEORY OF NONHYDROSTATICALLY STRESSED SOLIDS. W.B.Kamb.
phys. Res. (USA), Vol. 66, No. 1, 259-71 (Jan., 1961).
omparison, particularly for application to petrofabric prob-
of various current thermodynamic theories of nonhydrostatic-
stressed solids shows that the theories of Goranson (1930) and
nald (Geological Society of America Memoirs, 79, 1-8, 1960)
lentical, and that of Verhoogen (1951) suitably generalized,
s only in a way that has no effect on crystal stability as a
on of orientation. The theory of Gibbs (1906) and Kamb
nal of Geology, 67, 153-70, 1959a) differs in substantial feat-
from the other three theories. A close but contradictory re-
ship between the theoretical results of MacDonald and Kamb
rived. Close examination of the theory of MacDonald reveals
while superficially the theory appears suited to handling cer-
mechanical problems, it actually does not deal correctly with
. In fact, the derivation of the theory contains a fundamental
r, the correction of which leaves the theory without any content.
theories of Goranson and Verhoogen are contrasted with that of
s, and it is concluded that, among the outstanding theories, only
of Gibbs has any validity.

0326 USE OF STRAIN GAUGES IN MEASURING THE COMPRESSIBILITY OF A SOLID AT HIGH HYDRO-
TIC PRESSURES.
.Tikhomirova, A.V.Zalesskii and D.A.Tambovtsev.
stallografiya (USSR), Vol. 5, No. 5, 823-5 (Sept.-Oct., 1960).
ussian.
Describes the use of wire strain gauges (40 μ constantan
e with a paper base and having a resistance of about 100 ohms)
study compressibility pressures of up to 20 000 kg cm^{-2}. The
hod was tested on NaCl, CsI and LiF, on armco iron and on a
y hard alloy, T 15 K 6. The results agreed with Bridgman's
he Physics of High Pressures") and the method is stated to be
value in studies on phase transitions, anisotropy in compressi-
ity, etc. [English translation in: Soviet Physics—Crystallo-
phy (USA), Vol. 5, No. 5, 787-9 (March-April, 1961)].
J.Thewlis

A SIMPLE MECHANICAL ANALOGY FOR ISOTHERMAL
MPRESSION OF LIQUIDS AND SOLIDS. See Abstr. 15778

20327 ON THE PROPER MEASUREMENT OF DEFORMATION IN THE TENSILE TESTING OF PLASTIC METALS
D ALLOYS. W.Truszkowski.
ll. Acad. Polon. Sci., Vol. 8, No. 1, 53-61 (1960).
Algebraic formulae to represent the true stress versus
arithmic strain graphs obtained during the uniform elongation
gime of the tensile testing of metals are investigated. A (time-
dependent) power formula in terms of the "cold work" of the
ecimen is found to give the best fit when compared with experi-
ental results obtained with copper, mild steel and stainless steel.
e physical meanings of the constants of the equation are discussed.
H.Mykura

20328 THE DEFORMATION OF A TILT BOUNDARY UNDER APPLIED FORCES. A.N.Stroh.
cta metallurgica (Internat.), Vol. 9, No. 4, 315-19 (April, 1961).
The equilibrium positions of the dislocations forming a tilt
oundary are found when they are acted on by applied forces varying
oth periodically and aperiodically along the boundary. Explicit
pressions are obtained for the displacements when these are
nall; large displacements may be determined by using a relaxa-
on technique. The method is illustrated by a consideration of the
aximum force on a pinned dislocation in the boundary.

20329 THE DEFORMATION OF SOLIDS BY LIQUID IMPACT AT SUPERSONIC SPEEDS.
.P.Bowden and J.H.Brunton.
roc. Roy. Soc. A (GB), Vol. 263, 433-50 (Oct. 10, 1961).
A study was made of the deformation of solids at high rates of
rain which are produced by the impact of a small cylinder or jet of liquid on the surface of the solid. A method is developed for projecting this jet against the solid at velocities up to 1200 m/sec. The subsequent deformation of the solid under impact and the behaviour of the liquid is observed by high-speed photographic methods. The magnitude and duration of the impact load are also measured by using a piezoelectric transducer. The mode of deformation of the solid was investigated for plastic, elastic and brittle materials. There is evidence that the liquid jet, on impact, behaves initially in a compressible manner. Part of the deformation is due to these compressible effects and part to the shearing action of the liquid flowing at very high speeds across the surface. If the head of the jet has an appropriate shape (e.g. wedge shaped) the velocity of flow across the surface may be much greater than the velocity of approach. It is found that there are five general types of deformation produced in the solid. There are (i) circumferential surface fractures, (ii) subsurface flow and fractures, (iii) large-scale plastic deformation, (iv) shear deformation around the periphery of the impact zone, and (v) fracture due to the reflection and interference of stress waves. The predominating mode of deformation depends primarily on the mechanical properties of the solid and on the velocity of impact. The observations have a bearing on the practical problem of the erosion of aircraft flying at high speed through rain and on the erosion of turbine blades.

20330 LIMIT THEOREMS FOR A COULOMB MATERIAL OF NON-STANDARD DILATATION. D.Radenkovic.
C.R. Acad. Sci. (France), Vol. 252, No. 26, 4103-4 (June 26, 1961). In French.

Extends two results for standard materials (which have identical stress equations for the criterion of yield and the plastic potential) so that the former equation gives an upper bound and the latter a lower bound for the maximum stress in a non-standard material. A.E.Kay

THERMAL DILATION IN CRYSTALLINE MEDIA.
See Abstr. 17427

20331 THE STUDY OF PLASTIC DEFORMATION IN A METAL SHOWING DEFORMATION ANISOTROPY DUE TO PRELIMINARY LOADING. I.N.Izotov and Yu.I.Yagn.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 3, 576-9 (July 21, 1961).
In Russian.

Thin-walled nickel tubes were tested in tension, torsion, and simultaneous tension and torsion. The relationship between the vectors of true stress and true strain was investigated after preliminary loading, followed by partial or complete unloading. Relating these vectors by a modulus of plastic compliance, it is shown that the process of secondary plastic deformation can be described and predicted in terms of curves of constant modulus.
D.J.Barber

20332 THE LINEARIZATION OF EQUATIONS OF THE PLANE PROBLEM IN THE THEORY OF IDEALLY PLASTIC MEDIA. A.V.Sachenkov.
Dokl. Akad. Nauk SSSR, Vol. 140, No. 2, 330-2 (Sept. 11, 1961).
In Russian.

The linearization is performed by making use of St Venant stress functions. These are applied to both St Venant and the Mises—Schleicher plasticity conditions. The resulting linear differential equations are of similar type to the equations of hydrodynamics and the "telegrapher's" equations. [English translation in: Soviet Physics—Doklady (USA)]. J.K.Skwirzynski

20333 CORRELATION BETWEEN THE FLOW CONDITION OF A RIGID-PLASTIC BODY AND ITS FLOW LAW.
H.Ziegler.
Z. angew. Math. Phys. (Switzerland), Vol. 11, No. 5, 413-25 (Sept. 25, 1960). In German.

Supplies a proof, free from any physical assumptions, that von Mises' theory of the plastic potential, if valid for the elements of a rigid-plastic body, also holds for the representation in generalized strains and stresses.

20334 CORRELATION BETWEEN THE FLOW CONDITION OF AN ELASTIC-PLASTIC BODY AND ITS FLOW LAW.
H.Ziegler.
Z. angew. Math. Phys. (Switzerland), Vol. 12, No. 1, 53-68 (Jan. 25, 1961). In German.

For the case of a rigid-plastic body see the preceding abstract.

This paper supplies the analogous proof for an elastic-plastic body. Here, however, the yield surface deforms, even in the case of perfect plasticity. It is impossible to determine the shape of the yield surface without considering the real state of stress. Thus, the simplification resulting from the use of generalized coordinates is less than in the case of a rigid-plastic body.

20335 ON THE THEORY OF THE PLASTIC POTENTIAL. H.Ziegler.

Quart. appl. Math. (USA), Vol. 19, No. 1, 39-44 (April, 1961).

The theory of plastic potential can be established without hypothetical postulates which are open to criticism; the author presents purely mathematical proof of the theory in Prager's generalized form, applicable to rigid-plastic materials and to elastic-plastic solids. The present paper is a simplified and condensed version of two previous ones (see preceding abstracts). J.K.Skwirzynski

20336 EXTREMUM THEOREMS IN GENERAL VISCO-ELASTICITY. W.Olszak and P.Perzyna.

Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 9, No. 1, 17-24 (1961).

Variational theorems are derived for various anisotropic rheological models, the quantities undergoing variations being the stresses and strains. The authors claim that by introducing operational symbolism, generalizations can be made that are not possible by the classical treatment. K.Walters

20337 TENTATIVE EQUATIONS FOR THE PROPAGATION OF STRESS, STRAIN AND TEMPERATURE FIELDS IN VISCOELASTIC SOLIDS. S.C.Hunter.

J. Mech. Phys. Solids (GB), Vol. 9, No. 1, 39-51 (Feb., 1961).

A thermodynamic analysis of the "thermo-rheologically simple" solid proposed by Schwarzl and Staverman (Abstr. 7617 of 1952) leads to a set of thermomechanically coupled equations for the propagation of stress, strain and temperature fields in viscoelastic solids. The propagation of harmonic dilational waves is investigated in a linear approximation whose range of validity is ascertained; thermomechanical coupling effects appear to be more severe than for elastic solids.

20338 INTERPRETATION OF MATHEMATICAL SOLUTIONS IN VISCOELASTICITY THEORY ILLUSTRATED BY A DYNAMIC SPHERICAL CAVITY PROBLEM. F.J.Lockett.

J. Mech. Phys. Solids (GB), Vol. 9, No. 4, 215-29 (Nov., 1961).

Discusses the means by which physically meaningful results can be obtained from formal mathematical solutions to stress analysis problems in linear viscoelasticity theory. The discussion is illustrated by considering the effect produced by a rapid, but not discontinuous, change in pressure at the surface of a spherical cavity in an infinite medium. Results for the viscoelastic medium are compared with those for an elastic medium, and numerical solutions are presented graphically for typical cases.

20339 PERTURBATION METHODS IN PLASTICITY. I. PLANE STRAIN OF NON-HOMOGENEOUS PLASTIC SOLIDS. A.J.M.Spencer.

J. Mech. Phys. Solids (GB), Vol. 9, No. 4, 279-88 (Nov., 1961).

Perturbation methods can be applied to a number of problems in the plane strain of ideal plastic materials when the boundary conditions are such that exact analytical solution is not possible, and of materials which differ from the ideal plastic solid in that the governing equations contain additional terms which may be regarded as small. This paper is concerned with inhomogeneous rigid/plastic bodies whose yield stress $k(x,y)$ has the form $k^0 + \epsilon k'(x,y)$, where k^0 is constant and ϵ is small. A perturbation method of solving the equations for such a material is described; in this, approximate solutions for the inhomogeneous material are obtained as perturbations of corresponding solutions for a homogeneous material with yield stress k^0. The method is illustrated by application to the problem of punch indentation, and the perturbed stress, velocity and slip-line fields are obtained for this problem.

20340 A CLEAR INSTANCE OF RHEOPECTIC FLOW. J.B.Yannas and R.N.Gonzalez.

Nature (GB), Vol. 191, 1384-5 (Sept. 30, 1961).

From shearing stress against time data obtained under conditions of constant shear-rates, a viscous suspension is shown to exhibit rheopectic behaviour. The shear-rates used were moderately high, so that it would appear that an assertion made recently that rheopexy is associated with small shearing-rates is no longer valid. K.Wal

20341 ELASTIC—PLASTIC THERMAL STRESSES IN TUBE SUBJECTED TO UNIFORM HEAT GENERATION. EVALUATION OF EXPERIMENTAL RESULTS OBTAINED USIN GRAPHITE TUBES. T.Kammash.

Nuclear Sci. Engng (USA), Vol. 7, No. 5, 425-34 (May, 1960).

The elastic—plastic deformation of a tube subjected to radia uniform heat generation is considered using Tresca's yield funct its associated flow rule, and a linear work-hardening law. The tube is assumed to be in the state of plane strain and all the elast and thermal parameters are taken to be temperature independent For a uniform heat source Q, which increases monotonically with time and which has an insulated inner surface, yielding commenc at the inner boundary and propagates outward upon further therm loading. Immediately after initiation of yield, a plastic region (in and an elastic region (outer) are formed with the tangential stres as the intermediate principal stress in both regions. The maxim strength of a heat source, Q_M, to which a tube may be subjected i taken to correspond to that value of Q which makes the tube almos entirely plastic. This value of Q is computed for several graphite tubes of different thicknesses and then compared with an experimentally obtained Q_F which corresponds to total failure (fracture of these tubes. A value of approximately 2.5 is obtained for Q_F/Q for tubes of moderate thicknesses, Furthermore, the ratio Q_F/Q remains practically constant as tube thickness increases. Agreement between theory and experiment especially in depicting the dependence of failure load on tube thickness and temperature gradient is considered excellent in light of the many assumptions made. The application of this theory to the design of nuclear reactor fuel elements is also pointed out.

20342 THE DEFORMATION LAW FOR HIGHLY ELASTIC POLYMERS. G.L.Slonimskii.

Dokl. Akad. Nauk SSSR, Vol. 140, No. 2, 343-6 (Sept. 11, 1961). In Russian.

The deformation of highly elastic polymers is assumed to occur by the deformation of short molecular chains; the latter is shown to obey a general equation. The characteristics of the defo ation are shown to depend on a relaxation mechanism occuring i amorphous polymers. The general equation developed agrees wel with earlier empirical and phenomological relationships and, with the aid of the Boltzmann—Volterra theory, the elastic constants o the polymers can be calculated. [English translation in: Soviet Physics—Doklady (USA)]. D.J.Bar

20343 THE DYNAMIC BULK AND SHEAR VISCOSITY OF HIGH POLYMERS. I. R.Kono.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1580-6 (Aug., 1961).

The results of the transverse and longitudinal wave measurement on two groups of high polymers as a function of temperature at a frequency of 2.5 Mc/s are presented. One group contains those polymers with no or only slight steric hindrances, i.e. polyvinylchloride, vulcanized rubber and polytrifluoromonochloroethy The other group includes the materials with strong steric hindrances i.e. polyethyl methacrylate, poly-n-butyl methacrylate and poly-i-butyl methacrylate. The relaxation of shear deformati can be explained by the widely distributed relaxation times irresp tive of the coupling between the molecules and the steric hindranc of side chain groups on the main chain. On the other hand, the relaxation of volume deformation depends on the intermolecular force and the steric hindrance. In poly-i-butyl methacrylate, the relaxation associated with volume deformation may be explained by the single relaxation theory.

20344 FRICTION AND DEFORMATION OF POLYMERS. K.Tanaka.

J. Phys. Soc. Japan, Vol. 16, No. 10, 2003-16 (Oct., 1961).

The deformation of the surface of polymers caused by hard hemispheres of different radii was observed and the friction between the hemisphere and the plate was measured. The deform ation produced was deduced from Newton's rings and the grooved track. Hertz's equation was found to give the size of the contact circle. Wave-like deformation was observed near the contact region. When a tangential force was applied, the deformation increased on one side of the contact region and decreased on the other. Two types of sliding contact were observed; one was attributed to the retarded elasticity and the other to the frictional

g. From the former, the retardation time was obtained. The ction of grooved tracks was attributed to non-recoverable mation. The deformation was discussed in connection with n and the wave-like deformation of the polymer surface was sted as the source of frictional resistance.

45 ERINNERUNGSDEHNUNG IN HIGH POLYMER SOLIDS. K.Ito.

ap. Inst. Phys. Chem. Res. (Japan), Vol. 54, 194-8 (June,

training of linear polymer solids, "erinnerungsdehnung" in ular, was experimentally investigated in tension by using ose acetate plastics as test specimens. The relationship en flow strain and deformation strain is examined under various onditions of working and annealing temperatures, magnitude rked strain, rate of strain etc. The influence of amount of icizer DMP on this relationship is explored. Further, this ionship is discussed on the respective correspondence to ye Type" and "Box Type" relaxation spectra.

346 CREEP STRAIN RECOVERY METHOD FOR MEASURING TEMPERATURE DEPENDENCE OF RHEOLOGICAL AVIORS OF HIGH POLYMER SOLIDS. K.Ito.

Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, 362-88 (Dec., 19).

The creep strain recovery method is investigated theoretically experimentally as applied to measuring the temperature depend- of rheological behaviours of high polymer solids. The results niaxial compression are presented by using a cast resin of yl phthalate homopolymer as the test specimen of a space mer, and hard PVC (polyvinyl-chloride resin) as the test speci- of a linear polymer. The transition temperature to entropy ticity and flow temperature can be demonstrated clearly by creep compliance in strain recovery) versus θ (temperature) ves. The temperature dependence of characteristic relaxation es can be computed from J_C versus θ curves and compared with Williams—Landel—Ferry law (Abstr. 10019 of 1955) in regard its validity. The creep strain recovery method is extended to the e of the penetration of a steel ball which is considered to be a ple measuring method for this purpose. A general theory of ar viscoelasticity in a state under complex stress is analysed hematically by utilizing the Laplace transform and it is applied he Hertz contact problem for computing the creep recovery in penetration of steel ball measurement. In a similar manner as uniaxial compression method, the temperature dependence of racteristic relaxation times can be predicted from the experi- ntal results on z_{or} (residual depth of penetration creep recovery) sus θ curves by using the analytical results and is in good eement with that obtained from the results for uniaxial compres- n. The method by use of the RN (Rockwell number) versus θ ves obtained at a constant rate of temperature rise (2 deg C min^{-1}) a conventional Rockwell testing machine, is recommended as a mplest method and is successfully used for various high polymer lids, so that the effect of the difference in molecular structures the temperature dependence of rheological behaviours can be monstrated clearly. The results on thermosetting laminates are so presented. Further, the merits of these creep recovery ethods in both compression and penetration are discussed.

STORED ENERGY AND FLOW STRESS IN DEFORMED METALS. ee Abstr. 17509

20347 RESISTANCE TO DEFORMATION OF ALUMINIUM AND SOME ALUMINIUM ALLOYS. ITS DEPENDENCE ON EMPERATURE AND RATE OF DEFORMATION.

R.Arnold and R.J.Parker.

Inst. Metals (GB), Vol. 88, Pt 6, 255-9 (Feb., 1960).

Resistance to compressive deformation of commercially pure uminium, three non-heat-treatable aluminium alloys (Al—Mn, —2¼% Mg, and Al-5% Mg) and two heat-treatable aluminium alloys l—Si—Mg and Al—Cu—Si—Mg) was determined by experiments on cam plastometer. Data are presented for strain rates within the nge 1 to 30 in. in.$^{-1}$ sec^{-1}, and temperatures varying from 300° to 0°C. The resistance to deformation of aluminium alloys in the t-working range varies greatly; for example, the value for the gh-strength aluminium—5%magnesium alloy at 300°C is about eight nes that of commercially pure aluminium at 500°C. The higher- rength alloys were susceptible to thermal-softening effects, and sistance to deformation of these materials decreased after moder- e reductions.

20348 RELATION BETWEEN DEFORMATION AND INTEGRATED INTENSITY OF X-RAY IN ALUMINIUM SINGLE CRYSTALS. K.Nakajima.

Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 4, 324-33 (Aug., 1960).

The relation between the deformation and the integrated intensity of X-rays was investigated with aluminium single crystals, and it was found that with increasing slip deformation the reflected intensity first increased rapidly, and then gradually reached a saturation at about 2% elongation, irrespective of the tensile direction relative to the crystal orientation. The preferential deformation at the surface layer was deduced from the change in the integrated intensity of X-rays reflected from specimens of various thicknesses prestrained by a few per cent. It was seen that the region giving a maximum reflected intensity was not the outermost surface of the crystal but the inner layer about 10μ from the surface, and that with increasing deformation this region extended into the crystal. Further, the orientation dependence of the reflecting power in a plastically bent state was examined on (111) reflection by a Geiger counter diffractometer, and it was seen that the change in the reflected intensity related to the crystallographical relation of stress direction.

EFFECT OF DEFORMATION OF ALUMINIUM ON X-RAY DIFFRACTION. See Abstr. 15057

20349 CONTRIBUTION TO THE STUDY OF THE VISCOSITY OF GLASSES. M.Prod'homme.

Rev. Opt. (France), Vol. 39, No. 3, 95-135 (March, 1960). In French.

Measurements are made on 4 typical optical glasses, and on glycerol, B_2O_3, As_2S_5 and As_2Se_5. Viscosity η is determined from the rate of elongation under constant load at various temperatures T covering $\eta = 10^9$ to 10^{17} poise. η is found to increase with the duration of the load. An activation energy is calculated from the variation of η with T. The paper discusses the variations of η with composition, density and refractive index. G.F.Lothian

20350 PLASTIC DEFORMATION OF IRON SINGLE CRYSTALS. B.Jaoul and D.Gonzalez.

J. Mech. Phys. Solids (GB), Vol. 9, No. 1, 16-38 (Feb., 1961). In French.

20351 CONCERNING THE TEMPERATURE DEPENDENCE OF THE YIELD-POINT IN ARMCO-IRON. V.D.Yaroshevich.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3207-10 (Oct., 1961). In Russian.

The basic factors contributing to the yield-point in Armco-iron are determined and the temperature dependence (t.d.) of these factors is measured. It is shown that the t.d. of the yield-point is determined mainly by the t.d. of the movement of "free dislocations" (without atmospheres) through the lattice. The t.d. of the yield-point is measured when (a) "free dislocations" and (b) "aged dislocations", participate in plastic deformation. The difference between the curves (a) and (b) gives the t.d. of a factor characterizing the degree of interaction between dislocations and impurity atoms; the dependence is linear. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Barber

20352 COTTRELL LOCKING AND THE FLOW STRESS IN IRON. H.Conrad and G.Schoeck.

Acta metallurgica (Internat.), Vol. 8, No. 11, 791-6 (Nov., 1960).

The effect of temperature and grain size on the yield and flow stress of electrolytic iron at a constant structure was investigated. It was found that the flow stress σ_{fl} for a strain beyond the Lüders strain obeyed the equation

$$\sigma_{fl} = \sigma_{fl_1}(T) + \sigma_{fl_2}'(st) + kd^{-1/2},$$

where st represents the structure due to strain, solute atoms, precipitates, etc., and d is the grain diameter. The thermal component of the flow stress $\sigma_{fl_1}(T)$ exhibited the same temperature dependence as the lattice friction stress σ_i obtained from plots of the lower yield stress versus $d^{-1/2}$. The value of k was equal to that for the lower yield stress from 300° to 110°K. In this temperature range k was relatively independent of temperature. Below 110°K, k increased with decrease in temperature for the lower yield stress but not for the flow stress. It is suggested that this increase may be due to the occurrence of twinning. The equivalence of the temperature and grain size dependence of the lower yield and the flow stress suggests that the lower yield represents the movement of dislocation and does not include a thermally-activated locking term. Since the upper yield stress exhibited a stronger temperature dependence than the lower yield, it is suggested that this represents the tearing of dislocations from their Cottrell atmosphere.

20353 PHYSICAL PROPERTIES OF TITANIUM NITRIDE IN THE HOMOGENEOUS REGION.

G.V.Samsonov and T.S.Verkhoglyadova.
Dokl. Akad. Nauk. SSSR, Vol. 138, No. 2, 342-3 (May 11, 1961).
In Russian.

For abstract, see Abstr. 14870 of 1961. [English translation in: Soviet Physics — Doklady (USA), Vol. 6, No. 5, 429-30 (Oct., 1961)].

20354 THE PLASTIC DEFORMATION OF ALPHA-URANIUM.

A.G.Young, K.M.Gardiner and W.B.Rotsey.
J. nuclear Mater. (Internat.), Vol. 2, No. 3, 234-47 (Sept., 1960).

Experiments on the plastic behaviour of magnesium reduced alpha-uranium at temperatures above 300°C are reported. The first part of the work describes the results of uniaxial creep tests under isothermal conditions and presents a relation between secondary creep rate, stress and temperature which applies between 450°C and 650°C. The second part of the work describes the effects of thermal cycles on the plastic deformation under load. Experimental results are given and a theory developed to relate the plastic deformation to the applied stress and the amplitude of the cycle.

20355 THE PLASTIC DEFORMATION OF MONOCLINIC ALPHA PLUTONIUM.

S.E.Bronisz and A.E.Gorum.
J. nuclear Mater. (Internat.), Vol. 2, No. 4, 353-5 (Dec., 1960).

20356 THE DEPENDENCE OF CREEP BEHAVIOUR ON THE DURATION OF A SUPERIMPOSED FATIGUE STRESS.

A.H.Meleka and A.V.Evershed.
J. Inst. Metals (GB), Vol. 88, Pt 9, 411-14 (May, 1960).

The superposition of a fatigue stress in a creep experiment results in a sudden increase in the creep rate, which decreases with time, the strain following a $(\text{time})^{2/3}$ law. If the fatigue stress is removed, it is observed that the resulting creep rate is even less than the original static rate. This hardening, too, follows the $(\text{time})^{2/3}$ law. A model based on the increased mobility of an oscillating dislocation is proposed to explain the softening due to fatigue. The subsequent hardening is attributed to the effect of vacancies produced by the fatigue stress.

20357 THE ROLE OF VOIDS IN CREEP AND FRACTURE OF A PURE METAL.

P.W.Davies and J.P.Dennison.
J. Inst. Metals (GB), Vol. 88, Pt 11, 471-6 (July, 1960).

Voids were introduced into high-purity nickel by sintering to various densities, and their influence on creep and fracture behaviour was studied by comparison with vacuum-melted metal. Their most important effect appears to be the draining off of excess vacancies, resulting in a change in the activation energy for creep. This is shown to give an increase in creep rate of the observed order of magnitude. On this basis a theory of the initiation of tertiary creep in void-free metals is proposed, which suggests that the behaviour of these materials in compressive creep should be independent of pre-existing voids except for recrystallization effects. Confirmatory evidence was obtained. The work indicates that vacancy absorption is a relatively unimportant mechanism in the growth of voids.

20358 STRUCTURAL CHANGES IN COPPER SINGLE CRYSTALS DURING CREEP AT ELEVATED TEMPERATURES.

B.Ya.Pines and V.A.Sivochub.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2703-11 (Sept., 1961).
In Russian.

Structural changes in Cu single crystals, tested in creep at 1050°C, were studied by X-ray diffraction and microscopic examination of the specimen surface. Formation of slip bands and asterism were observed in test pieces deformed under an applied stress $p > 100\ \text{g/mm}^2$. No such evidence of structural changes was found in specimens which were deformed to 10% elongation when tested in creep under $p = 50\text{-}70\ \text{g/mm}^2$, from which a diffusion character of creep under these conditions was inferred. [English translation in: Soviet Physics—Solid State (USA)]. M.H.Sloboda

20359 EASY GLIDE OF LEAD SINGLE CRYSTALS.

R.L.Fleischer.
Acta metallurgica (Internat.), Vol. 9, No. 3, 184-90 (March, 196

Lead single crystals, like those of other f.c.c. metals, show easy glide, the amount increasing with the quantity of dissolved impurity and decreasing with the content of insoluble impurity. Like aluminium, lead has no linear stage II, but in contrast to aluminium it shows no measurable creep at 4.2°K. The impuri effects may be understood by applying a model due to Diehl.

20360 FATIGUE-INDUCED AFTER-EFFECT IN ZINC SINGLE CRYSTALS.

A.H.Meleka and G.B.Dunn.
J. Inst. Metals (GB), Vol. 88, Pt 9, 407-10 (May, 1960).

Negative strain rates are known to occur on unloading in cre experiments on polycrystalline metal specimens. Previous attempts to reproduce this "after-effect" in single crystals have failed, and this fact has formed the basis for certain theories of creep-strain recovery. The results now reported show that the after-effect can occur in zinc single crystals if a fatigue stress i superimposed. In polycrystalline specimens also a superimpose fatigue stress increases the recovery of creep-strain. The resul are explained by the enhanced dislocation mobility due to the fatigue stress.

20361 GRAIN-BOUNDARY SLIDING IN COPPER BICRYSTA

J.Intrater and E.S.Machlin.
J. Inst. Metals (GB), Vol. 88, Pt 7, 305-10 (March, 1960).

The phenomenon of grain-boundary sliding (motion of grains along a common boundary) has been studied in bicrystals of coppe so oriented as to minimize slip in the adjoining grains. Sliding occurred within a very narrow zone and differed markedly in a number of respects from the behaviour recorded by previous investigators. It is suggested that two different physical phenome have been observed which act to produce tangential grain displacements along a common boundary: one is ideal grain-boundary sliding, and the other is grain-boundary-zone shear. Both have been investigated. Sliding is spasmodic, with no incubation time. The amount of sliding varies as the $\frac{2}{3}$ power of the time and occur with an activation energy of 40 000 cal/mole when the test is carri out in a vacuum of 5×10^{-4} mm Hg, and 20 000 cal/mole when in hydrogen. Voids are produced by grain-boundary sliding, their number being dependent upon the amount of sliding and independer of temperature. Grain-boundary-zone shear was produced at will by plastically deforming such a zone at room temperature before subjecting the boundary to a shear stress at high temperature. It is suggested that the phenomenon of work-softening is responsi for grain-boundary-zone shear. Grain-boundary sliding was foun together with zone shear but not vice versa. A theory of grain-boundary sliding is presented, in which grain-boundary migration is the rate-controlling process.

20362 MICROSTRUCTURE OF THE INDENTATIONS OBTAINED DURING MICROHARDNESS MEASUREME ON GERMANIUM.

M.S.Ablova.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3133-6 (Oct., 1961).
In Russian.

Microscopic examination of the indentations made by the diamond pyramid during microhardness testing of Ge reveals the presence of light and dark bands, and photographs of the bands ar reproduced. It is suggested that the bands are slip lines caused b secondary plastic deformation arising from residual elastic stres [English translation in: Soviet Physics—Solid State (USA)]. R.F.S.Hearm

20363 DISLOCATIONS IN CRYSTALS OF IRON-SILICON ALLOYS INDENTED BY A BALL.

B.Šesták and S.Libovický.
Czech. J. Phys., Vol. 11, No. 6, 444-51 (1961).

Slip bands inside the area deformed by the indentation of a ste ball are studied by the method of making dislocations visible by etching on the surfaces of iron-silicon alloys. The shape of the sl surfaces is examined and the dimensions of the deformed area as a function of the silicon content, of the temperature and of the deformation speed are determined. The observed slip is microphysically explained assuming that parts of the screw dislocations if moving, show a cross-slip.

364 **SURFACE MARTENSITE AND PLASTIC DEFORMATION.** A.Mašín and O.Bakalíková.
C h. J. Phys., Vol. 11, No. 2, 144-9 (1961). In German.

The influence of surface martensite in Kovar sheet on the pl ic deformation of the austenite was investigated. As expected fr its small thickness, the martensite has only a minor effect. O small slip lines are stopped by the martensite particles; st ng slip lines are unaffected and the martensite particles are di laced during deformation. H.Mykura

0365 **MECHANICAL PROPERTIES OF TELLURIUM SINGLE CRYSTALS.** R.J.Stokes, T.L.Johnston and C.H.Li.
A metallurgica (Internat.), Vol. 9, No. 5, 415-27 (May, 1961).

The mechanical behaviour of chemically polished single c stals was determined for the three following orientations. (1) t ion direction parallel to $[11\bar{2}0]$ (2) parallel to $[10\bar{1}0]$ and (3) p allel to $[0001]$ direction. Slip occurs in the $\langle 11\bar{2}0\rangle$ directions o r $\{10\bar{1}0\}$ planes which are also the planes of cleavage. Speci- r ns favourably oriented for slip (i.e. (1) and (2) are extremely s (critical resolved shear stress, 300 lb.in^{-2}) and ductile (exceeding 2 er cent elongation), providing great care is taken in their prepara- t n and handling. For crystals of orientation (1) the active slip p ne rotates towards the plane of maximum shear stress favouring c tinued single slip. For orientation (2), reorientation during p stic flow raises the stress on the inactive plane and favours c lex slip. A higher rate of work hardening for orientation (2) t n for (1) and the appearance of slip bands for the two orientations consistent with this expected difference in slip behaviour. For entation (3) there is no shear stress over $\{10\bar{1}0\}$ these speci- ns are strong and brittle. They can support normal stresses of 000 lb/in^2 without plastic deformation. The deformation and cture characteristics for each orientation can be correlated with anisotropy of the chemical bonding in tellurium. The nature of dislocations and their interactions are also discussed.

COLD-WORKING IN F.C.C. METALS. See Abstr. 17527

20366 **THE TEMPERATURE DEPENDENCE OF SOME CHARACTERISTICS OF THE HARDENING CURVE OF NC SINGLE CRYSTALS.** M.Boček.
ech. J. Phys., Vol. 10, No. 11, 830-40 (1961). In German.

The effect of temperature between 225° and 344°K on the aracteristics of the hardening curve of pure zinc crystals is termined. See also following abstract. R.F.S.Hearmon

20367 **THE INFLUENCE OF IMPURITY CONTENT ON SOME CHARACTERISTICS OF THE HARDENING CURVE OF NC SINGLE CRYSTALS.** M.Boček.
ech. J. Phys., Vol. 10, No. 11, 841-55 (1961). In German.

The influence of small amounts of Cu, Pb and Cd on the rdening curves in tension of variously orientated zinc single ystals is investigated. The critical shear stress, the hardening oefficient and other characteristics of the curves are determined d discussed in relation to the occurrence of vacancies and dis- cations. See also preceding abstract. R.F.S.Hearmon

HARDENING DUE TO THE RECOMBINATION OF ISLOCATIONS. See Abstr. 19771

20368 **THE EFFECT OF STRUCTURAL IMPERFECTIONS ON THE AGE-HARDENING OF ALUMINIUM–ZINC ALLOYS.**
.D.Garwood and A.L.Davies.
. Inst. Metals (GB), Vol. 88, Pt 7, 311-17 (March, 1960).

The age-hardening of aluminium alloys containing 9, 17, and 5% zinc, respectively, was studied at room temperature. A erious discrepancy existed between the observed rate of hardening nd that calculated from the value of the diffusion coefficient, D_{Zn}, extrapolated to room temperature. In addition, the rate of ardening of specimens with a structure of strain-free, recrystal- ized grains was found to depend upon the temperature within the ingle-phase region from which the alloy was quenched. Both these bservations can be explained by the hypothesis that a large concentration of vacant sites is retained in the lattice on quenching rom a high temperature. The extent of hardening in recrystallized rains was independent of the quenching temperature, except when he concentration of vacancies decayed to the equilibrium value efore maximum hardness was attained. When this occurred, the geing curves consisted of two distinct stages, the rate of hardening uring the second stage agreeing with the calculated value. Hardening immediately after quenching was restricted in grains that did not recrystallize during solution-treatment. It is suggested that this is due to the rapid elimination of the excess vacancies at the dislocation networks and arrays which constitute the substructure. The diffusion coefficient then falls to its normal value before the zinc atoms have clustered to an appreciable extent. The slow hardening observed in non-recrystallized regions over a prolonged period is consistent with this explanation.

20369 **THE DEFORMATION OF SINGLE CRYSTALS OF ALUMINIUM–4.5% COPPER ALLOY.**
G.Greetham and R.W.K.Honeycombe.
J. Inst. Metals (GB), Vol. 89, Pt 1, 13-21 (Sept., 1960).

The deformation characteristics of single crystals of an aluminium–45% copper alloy in several heat-treated conditions were studied at 77°K. While supersaturated air-cooled crystals have a low flow stress and a small rate of work-hardening, crystals aged at 130°C to give G.P.[1] zones have a flow stress three times as great and a marked yield point followed by a period of negligible hardening. The mode of deformation undergoes a further pronounced change on ageing at 190°C (optimum ageing), when no yield point is observed and the crystals strain-harden rapidly. Thoroughly overaged crystals gave a very low flow stress but a rate of work-hardening comparable with that of the optimum-aged crystals. Comparative tests of crystals at 77 and 293°K emphasized the effect of different ageing treatments. The resting at room temperature of crystals deformed at 77°K produced yield phenomena under all four conditions; in particular, marked strain-age-hardening occurred in the solution-treated crystals, and to a lesser extent in the aged crystals, while Cottrell locking was clearest in the overaged crystals.

20370 **THE LONG-TERM STRENGTH OF METALS.** V.I.Likhtman, L.S.Bryukhanova and I.A.Andreeva.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 2, 359-62 (July 11, 1961). In Russian.

For abstract, see Abstr. 14907 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 7, 622-4 (Jan., 1962)].

20371 **TESTING OF WHISKER CRYSTALS IN TENSION AND BENDING.** É.M.Nadgornȳi and A.V.Stepanov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1068-73 (April, 1961). In Russian.

An apparatus is described for measuring the strength properties of whisker crystals, and results are reported for tests on whiskers of quartz, Cu, Si, Sn, Te, Zn, ZnS, KCl, NaCl and hydroquinone. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 778-82 (Oct., 1961)]. R.F.S.Hearmon

20372 **THE MECHANICAL PROPERTIES OF ALUMINIUM–LITHIUM ALLOYS.** W.R.D.Jones and P.P.Das.
J. Inst. Metals (GB), Vol. 88, Pt 10, 435-43 (June, 1960).

The mechanical properties of aluminium–lithium alloys made from high-purity materials were determined. The best combination of properties in the binary system is given by alloys with a lithium content of ~ 2-2½% after solution-treatment at 580°C and ageing at 130°C. The alloys are capable of age-hardening; the strength is increased, but the ductility is decreased, and this has restricted their use. A third metal (zinc, magnesium, tin, or copper) has been added to the 2% lithium alloy in an attempt not only to increase its strength without sacrificing too much ductility, but also to increase the proof stress so that high ductility values may not be of primary importance. Preliminary tests showed that additions of zinc and of tin did not result in any substantial improvement. Additions of magnesium and of copper are beneficial after certain treatments; ~ 1% magnesium or copper produces sheets which, in the hot-rolled, solution-treated, and aged condition, have a proof stress, tensile strength, and elongation of 11 ton in^{-2}, 17 ton in^{-2}, and 14% respectively, thus giving a value of ~ 7 for the strength : weight ratio. Higher strengths can be attained, but only at the expense of ductility; e.g. when the magnesium content was increased to ~ 1½%, sheets cold rolled and subsequently aged had a strength of 26 ton in^{-2} with an elongation of only 6½%, and with ~ 2½% copper the corresponding values were 32 and 5. Although these figures are not promising for commercial purposes, the alloys have an advantage in that the proof stress is high and that it is possible to obtain a value of ~ 12 for the strength : weight ratio.

20373 TENSILE PROPERTIES OF ANNEALED CHROMIUM BETWEEN −196 AND +900°C. C.W.Weaver.

J. Inst. Metals (GB), Vol. 89, Pt 10, 385-90 (June, 1961).

The tensile properties of high-purity extruded chromium in the annealed condition were established between −196° and + 900°C. The brittle → ductile transition was sensitive to nitrogen content. Chromium containing 0.002% N_2 was brittle below 350°C, but with 0.0005% N_2 the transition occurred below 150°C. In the ductile condition marked yielding and strain-ageing effects were found. The brittle-fracture stress was highly temperature-dependent, varying linearly with reciprocal absolute temperature between +100° and −100°C, as would be expected if the measured stress were actually that for pre-fracture yielding. Negative strain-rate effects occurred at low speeds at strain-ageing temperatures, indicating strain-induced precipitation, and a high rate of work-hardening was found. Systematic changes in the appearance of brittle-fracture surfaces with temperature were observed, and these are thought to be due to changes in the velocity of fracture. Ductile necked fractures contained large cavities which had grown from oxide-filled cavities during necking.

20374 STRENGTH OF VACUUM-DEPOSITED COPPER FILMS. L.S.Palatnik and A.I.Il'inskii.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2813-19 (Sept., 1961). In Russian.

A method was developed of preparing vacuum-deposited Cu films in a form suitable for tensile tests. The mechanical properties of films studied were independent of their thickness (13-150 μ), but decreased with decreasing temperature, t_s, of the substrate. Maximum UTS of 85 kg/mm² and microhardness of 300 kg/mm² were observed on specimens deposited on substrates at t_s = 70°C. [English translation in: Soviet Physics—Solid State (USA)].

M.H.Sloboda

20375 STRENGTH, STABILITY, AND THE EQUICOHESIVE POINT. E.E.Underwood.

J. Inst. Metals (GB), 266-71 (Feb., 1960).

A series of high-purity alloys based on iron-18% chromium, balance nickel, was prepared to include the α, $(\alpha + \gamma)$, and γ phase fields. Strengths were measured by means of creep, tensile, and hardness tests. Stability was evaluated from the rate of decrease of high-temperature strength with time. It is shown that the ambiguity connected with the equicohesive temperature can be eliminated when time or strain-rate effects are accounted for, thus conferring a unique value on the transition between low- and high-temperature behaviour. This fixed value is called the equi-cohesive point, rather than the equicohesive temperature.

20376 DYNAMIC TENSILE STRENGTH OF A FERROELECTRIC CERAMIC. R.Gerson, S.R.Burlage and D.Berlincourt.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1483-5 (Nov., 1961).

The dynamic tensile strength of a piezoelectric lead titanate zirconate ceramic used for power transducers was tested by driving small bars of ceramic electrically at their longitudinal resonance until they fractured. The measured dynamic tensile strength of small specimens of ceramic of good quality was found to be about 13 000 p.s.i. This value was very drastically reduced for ceramic which was not of optimum quality.

20377 THE TENSILE PROPERTIES OF HEAVILY DEFORMED MOLYBDENUM AFTER NEUTRON IRRADIATION.

D.N.Sethna, A.A.Johnson, K.J.Proud and S.S.Sheinin.

J. Inst. Metals (GB), Vol. 89, Pt 12, 476-8 (Aug., 1961).

The ductile—brittle transition temperature of heavily swaged molybdenum of commercial purity was measured before irradiation and after irradiation to doses of up to 4×10^{19} nvt. The tests were carried out in a Hounsfield tensometer at a strain rate of 0.88×10^{-4} sec^{-1}, and the transition temperature was taken to be the highest temperature at which no appreciable plastic strain occurred before fracture. The transition temperature both before and after irradiation was found to be −110° ± 10°C.

20378 THE TENSILE STRENGTH OF SOME REFRACTORY METALS AT HIGH TEMPERATURES. B.L.Mordike.

J. Inst. Metals (GB), 272-5 (Feb., 1960).

The tensile strengths of the refractory metals niobium, tantalum, tungsten, and molybdenum were measured in the range 0-2300°C. Up to 800°C a standard Hounsfield tensometer was used, but from 800° to 2200°C the measurements were made in a carbon-tube vacuum furnace. The behaviour of these metals was comparable in every respect, at equivalent homologous temperatures, with th of the lower-melting-point metals. The upper temperature limit was imposed by a reaction between carbon vapour from the furna tube and the specimen. Above 2000°C a carbide was formed on th surface and diffused into the specimen, thereby affecting the mechanical properties appreciably.

20379 THE EFFECT OF NEUTRON IRRADIATION ON THE TENSILE PROPERTIES OF ZIRCALOY-2.

L.M.Howe and W.R.Thomas.

J. nuclear Mater. (Internat.), Vol. 2, No. 3, 248-60 (Sept., 1960).

Tensile specimens of annealed, 13.1% cold-worked, and tempered 25.5% cold-worked Zircaloy-2 were irradiated at 220°C and 280°C with integrated fast-neutron fluxes of 3.6×10^{19} n/cm² and 2.7×10^{20} n/cm² respectively. Post-irradiation tensile tests performed at room temperature and 280°C showed that considerab irradiation hardening occurred in all the irradiated material. Thi change was characterized by an increase in the proportional limit yield stress, and ultimate tensile strength, and a decrease in the total and uniform per cent elongations. The per cent changes in mechanical properties as a result of the irradiation were greater in the annealed material than in the cold-worked material. The tensile properties of irradiated 13.1% cold-worked material were almost identical to those for the irradiation tempered 25.5% cold-worked material for both levels of irradiation. A yield point was developed in irradiated annealed material tested at 280°C whereas no yield point was present in the same material tested at room temperature. Results are also given for post-irradiation annealing studies performed on the annealed and cold-worked material irradiated at 280°C.

20380 MEASUREMENT OF TENSILE STRENGTH OF GRANULAR BRITTLE MATERIALS.

H.Yoshikawa and T.Sata.

Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, 389-92 (Dec., 1960).

A method of measuring the tensile strength of granular brittle materials such as abrasive grains is proposed. Reliability of this method is examined through experiment on aluminium oxide abrasi grains. Size effect on the strength of tested materials is discussed from the point of view of Griffith crack distribution in materials.

20381 THE EFFECT OF COMPOSITION AND STRUCTURE ON THE TENSILE PROPERTIES OF HIGH-PURITY IRON SINGLE CRYSTALS, WITH PARTICULAR REFERENCE TO THE QUESTION OF BRITTLE FRACTURE. B.Edmondson.

Proc. Roy. Soc. A (GB), Vol. 264, No. 1317, 176-97 (1961).

Single crystals of iron subjected to uniaxial tensile stress deformed by slip at temperatures down to about −145°C independen ly of their orientation. Between −145° and −196°C their behaviour depended on orientation and at −196°C crystals stressed in a direction within about 25° of a [001] direction featured by cleavage without any prior deformation by slip. The range of orientation over which brittle cleavage occurred was increased at lower temperatures and all crystals tested were brittle at liquid-helium temperature. At any one temperature the brittle orientation range was increased by additions of small amounts of nitrogen or carbon to the iron, by ageing the crystals at room temperature, and by comparatively short exposure to neutron irradiation. The results of the tests were consistent with the cleavage strength obeying a critical normal stress law. Some evidence is given which suggests that fracture may be initiated at the intersection of a pair of twins in the appropriate (001) plane.

20382 TRAJECTORIES OF BRITTLE RUPTURE CRACKS AS GEODESIC LINES ON THE SURFACE OF A BODY.

E.M.Morozov and Ya.B.Fridman.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 87-90 (July 1, 1961). In Russian.

For abstract, see Abstr. 14914 of 1961. [English translation i Soviet Physics—Doklady (USA), Vol. 6, No. 7, 619-21 (Jan., 1962)].

20383 EFFECT OF SURFACE-ACTIVE METALLIC MELTS ON THE CREEP RESISTANCE OF METALS.

L.S.Bryukhanova, I.N.Andreyeva and V.I.Likhtman.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 9, 2774-8 (Sept., 1961). In Russian.

The time-temperature dependence of strength of single Zn crystals and polycrystalline Zn and Cd wire specimens, coated wit 5 μ thick Hg (in the case of Zn) and Ga (in the case of Cd) films, was studied. Discontinuities were observed in the τ/p (time-to-ru re/applied stress) curves in the low p range, where a small inc ase in p brought about a decrease in τ from several days to a fr ion of a second. This effect was attributed to a change in the m anism of fracture, associated with a large decrease in the fr surface energy of the metals studied in the presence of a su ce-active medium. The new mechanism begins to operate when th ormal stresses reach a critical level, corresponding to the br e strength of the stressed specimen. The brittle strength of a tal in contact with a surface-active medium is considerably lo r than its normal value, and under these conditions the kinetics of ack propagation is determined by the rate of spread of the su ace-active coating towards the fracture zone, and is no longer as ciated with the thermal activation of the process of fracture. [E lish translation in: Soviet Physics—Solid State (USA)].

M.H.Sloboda

384 CLEAVAGE FRACTURE IN NIOBIUM.
A.T.Churchman.

J. st. Metals (GB), Vol. 88, Pt 5, 221-2 (Jan., 1960).

Niobium with a sufficiently high interstitial impurity content a a coarse grain size has a ductile ⇌ brittle transition tempera-t . In the brittle range, cleavage occurs on both (100) and (110) p es.

20385 CLEAVAGE OF URANIUM DIOXIDE.
A.Portnoff-Porneuf.

J uclear Materials (Internat.), Vol. 2, No. 2, 186-8 (June, 1960). rench.

Microscopy and X-ray analysis of fracture surfaces of small le crystals of UO_2 shows that the cleavage surface is a ays (111).

A.F.Brown

0386 POROSITY IN PLASTICALLY DEFORMED SINGLE CRYSTALS.
F.D.Rosi and M.S.Abrahams.

a metallurgica (Internat.), Vol. 8, No. 11, 807 (Nov., 1960).

Single crystals of Ag, Cu and Cu—1% Al, with crystal axes of 0⟩ orientation, were extended slowly (0.003 strain per min) to cture in tension. Cu specimens had knife-edge fracture surfaces, specimens "V"-type fracture surfaces. Reduction in area was rly 100%. On sectioning, porosity was observed near the cture surface in all cases. The porosity is ascribed to the densation of vacancies produced by multiple glide. It is suggested t the transition from transcrystalline to intercrystalline fracture polycrystalline materials at the "equicohesive temperature" is o due to vacancies produced by multiple glide, which condense form porosity at grain boundaries.

H.Mykura

20387 THE KINETICS OF GROWTH OF "SILVER" CRACKS IN TRANSPARENT SOLID POLYMERS.
I.Bessonov and E.V.Kuvshinskii.

z. tverdogo Tela (USSR), Vol. 3, No. 5, 1314-23 (May, 1961). Russian.

For abstract, see Abstr. 12607 of 1961. [English translation Soviet Physics—Solid State (USA), Vol. 3, No. 5, 950-7 (Nov., 61)].

20388 TRANSPARENCY OF GLASS AND CERTAIN PLASTICS UNDER SHOCK ATTACK.
D.Mallory and W.S.McEwan.

appl. Phys. (USA), Vol. 32, No. 11, 2421-4 (Nov., 1961).

The belief that transparent plastics quickly go opaque under rong shock wave attack was investigated. High-speed photo-aphs are shown, and it is seen that Lucite and Plexiglas do not opaque until shattered by tension waves. The behaviour of ate glass is somewhat similar. By adjustment of dimensions d lighting, events can be observed to a high photographic quality rough the shock front for an undetermined length of time.

20389 CREEP AND HARDNESS OF METALS: A PHYSICAL STUDY.
T.O.Mulhearn and D.Tabor.

Inst. Metals (GB), Vol. 89, Pt 1, 7-12 (Sept., 1960).

In a study of the effect of time of loading on the indentation ardness of metals, measurements were carried out on indium and ad from liquid-air temperature to 50° C below the melting point. spherical indenter was used and loading times were varied from 0^{-4} to 10^3 sec. Apart from some preliminary experiments, the udy was confined to single crystals. In general, the hardness or eld pressure p decreases with loading time t. Above ~ 0.6 T_m, here T_m is the melting temperature (°K), and for times of loading xceeding a few seconds, a linear relationship exists between log p and log t. In this temperature range, experiments carried out at various temperatures give a series of parallel lines, the separation between them providing a measure of the activation energy involved. The values obtained are 16 kcal/mole for indium and 28 kcal/mole for lead, which are close to the activation energies for self-diffusion. Metallurgical examination shows that there is negligible recrystallization or other grain-boundary effects during the course of one experiment. The deformations around the indentation correspond to slip, suggesting that the rate-limiting process to creep in this temperature range is dislocation climb. If the loading time is reduced below ~ 1 sec, there is a marked rise in hardness, and for values of t less than ~ 10^{-3} sec an upper limit to p is reached (p_{max}) which is the same whatever the initial temperature of the experiment. In the case of indium the deformation also changes from slip to twinning. If hardness measurements are made at liquid-air temperature, the hardness is almost independent of loading time and is roughly equal to p_{max}. With indium the deformation at these low temperatures occurs by twinning, whatever the loading time. It is apparent that for temperatures > 0.6 T_m the creep process is dominated by a self-diffusion mechanism. If the loading time is too short or if the temperature is very low, this mechanism cannot operate and the hardness is greatly increased.

20390 AN [INDENTATION] INSTRUMENT FOR MEASURING THE HARDNESS OF METALS UNDER VERY HIGH PRESSURE.
L.F.Vereshchagin, V.A.Gladkovskii and M.I.Oleinik.

Pribory i Tekh. Eksper. (USSR), 1958, No. 4, 103 (July-Aug.). In Russian.

The instrument provides for static tests under pressures up to 10 000 kg/cm². [English translation in: Instrum. exper. Tech. (USA), No. 4, 571-2 (July-Aug., 1958; publ. June, 1959)].

HARDNESS OF ELECTRODEPOSITED CHROMIUM. See Abstr. 20713

20391 RADIATION HARDENING OF COPPER SINGLE CRYSTALS.
T.H.Blewitt, R.R.Coltman, R.E.Jamison and J.K.Redman.

J. nuclear Mater. (Internat), Vol. 2, No. 4, 277-98 (Dec., 1960).

The effect of nuclear radiation on the mechanical properties of copper was studied. It was found that the yield stress, which is substantially increased by the radiation, increases as the cube root of the flux. A strong temperature dependence of the yield stress of irradiated copper was observed with the yield stress being given by a function similar to $\tau = A - BT^{1/2}$ above 40° K. A Lüders band with slip lines of very large step height was associated with the enhanced yield stress at small strains. At large strains the phenomenon of overshoot was observed. The annealing kinetics of the radiation hardness were also studied in the temperature range from 25° to 700° K. Little or no annealing was observed in the region below 80° K. In the region from 80° to 300° K approximately 20% of the yield stress is recovered, with the remainder annealing in the range from 600° to 700° K. These results are discussed in terms of the possible mechanisms by which the hardening can occur. While by no means conclusive, these data support a dislocation locking mechanism. On the other hand a very close analogy exists between radiation hardening and the hardening which arises from the addition of impurities, e.g. the hardening in α-brass. The correlation between work hardening and radiation hardening appears to be quite small.

20392 SECONDARY HARDNESS AND RED HARDNESS OF HIGH-SPEED STEEL.
P.M.Yushkevich.

Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 1, 100-8 (1960). In Ukrainian.

Secondary hardness arises as a consequence of dispersion hardening of both primary and secondary martensite. When steel is at its maximum hardness, α-phase blocks are equal to 1.25×10^{-6} cm, while type II distortions are equal to 4×10^{-3}. The higher the hardness of the steel, the higher the concentration heterogeneity of the α-phase. Red hardness of steel follows from α-phase block resistance to the consolidation and relaxation of type II distortions. This resistance is, however, associated with the quantity of chromium in the steel, i.e. with chromium carbide coalescence.

20393 THERMAL AND MECHANICAL EFFECTS IN THE CAVITATION ZONE ON A METAL SURFACE.
V.V.Gavranek, D.N.Bol'shutkin and V.I.Zel'dovich.

Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 2, 262-8 (Aug., 1960). In Russian.

It is shown analytically that in the course of cavitation erosion, induced by a magnetostrictive vibrator operating at a frequency of 7.5 kc/s, the pulsating pressure increases to 550 kg/cm^2 in $\sim 10^{-5}$ sec and acts on an area of $\sim 10^{-5}$ mm^2, and that the metal temperature in the vicinity of the cavitation zone may rise to 400-500°C. These conclusions were confirmed experimentally by establishing that (a) the structure of a hardened steel near the cavitation zone undergoes changes similar to those brought about by tempering at 470°C; (b) the rate of cavitation erosion of hardened steel is the same as that of steel tempered at a temperature > 400°C, and (c) solution-treated Cu—Al alloys age-harden in the course of cavitation erosion. M.H.Sloboda

20394 RESISTANCE OF POLYMER PLASTICS TO EROSION BY CAVITATION. K.K.Shal'nev.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 60-2 (July 1, 1961).
In Russian.

Qualitative tests in a water tunnel to determine on a relative scale the ability of various metals and plastics to resist erosion by flow-induced cavitation are described. A correlation between ability to resist cavitation damage and physical properties is suggested. Some plastics were more durable than aluminium, bronze, or the alloy EI-437B under the test conditions. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 7, 567-70 (Jan., 1961)]. J.M.Taylor, Jr

20395 RESISTANCE OF WHITE SAPPHIRE AND HOT-PRESSED ALUMINA TO COLLISION WITH LIQUID DROPS.
O.G.Engel.
J. Res. Nat. Bur. Stand. (USA), Vol. 64A, No. 6, 499-512 (Nov.-Dec., 1960).

Fused alumina has been reported to be one of the most promising materials for resistance to erosion due to high-speed collision with liquid drops. In this paper, data are presented that show the resistance of 0.318 cm (0.125 in.) thick plates of white sapphire and hot-pressed alumina to impingement damage by 0.2 cm dia. waterdrops and mercury drops. The type of damage done to these high-strength ceramics as a result of collision with a mercury drop at high velocity was found to be qualitatively the same as that produced on low-strength plastics as a result of collision with a waterdrop at relatively low velocity. In collision with mercury drops, the velocity at which damage was first observed was 3.514×10^4 cm/sec (1,153 ft/sec) for white sapphire and 4.276×10^4 cm/sec (1,403 ft/sec) for hot-pressed alumina; the difference in the velocities found for the two ceramics is not considered to be significant. The velocity required to damage these ceramic materials on collision with a waterdrop was not reached experimentally. A theoretical extrapolation suggests that plates of these ceramics of the indicated thickness can be expected to survive collision with a 0.2 cm waterdrop without damage up to a velocity of 33.7×10^4 cm/sec (11,100 ft/sec). For air at 0°C, this is equivalent to a Mach number of 10.

20396 ON A TWO-TERM FRICTION LAW.
I.V.Kragel'skii.
Dokl. Akad. Nauk SSSR, Vol. 140, No. 5, 1048-50 (Oct. 11, 1961).
In Russian.

Suggests a new, two-term formula for the friction coefficient of metals. The first of the terms is due to the "internal" friction associated with the motion of surface layer in the direction of friction (and causing a volume deformation of the metal); the second term is due to the "external" friction associated with the motion of surface layer in the direction normal to the direction of friction (causing only a surface displacement). [English translation in: Soviet Physics—Doklady (USA)]. J.K.Skwirzynski

20397 MEASUREMENTS OF RETARDED VAN DER WAALS' FORCES.
W.Black, J.G.V.de Jongh, J.T.G.Overbeek and M.J.S.Sparnaay.
Trans Faraday Soc. (GB), Vol. 56, Pt 11, 1597-1608 (Nov., 1960).

Molecular attractions were measured between pairs of flat quartz plates and between a flat and a spherically curved plate. Considerable precautions were taken against spurious electric charges, dust and gel particles which might interfere with the measurements. Silicone oil was used for damping. Distances between the flat plates were varied from 5000-9500 A, and from 940-5000 A for the plate and sphere combination. Attraction forces varied from 0.002-0.3 dyne. The results agree with the presence of retarded van der Waals' forces (Casimir and Polder, Lifshitz). If the force per unit area between flat plates is represented by $F = -B/d^4$, the value of $B = 1\text{-}2 \times 10^{-19}$ erg cm, is in good agreement with existing theories, and with the previous experimental results obtained by Derjaguin and Abrikosova and by Kitchener and Prosser. An explanation is suggested why earlier measurements by Overbeek and Sparnaay using a similar method led to much stronger attractions.

STRUCTURE OF SOLIDS

20398 REVERSIBLE PHASE TRANSITION OF PHOSPHORUS PENTOXIDE. I.B.Johns, H.E.Ulmer and J.W.Edwards.
J. chem. Phys. (USA), Vol. 35, No. 4, 1271-2 (Oct., 1961).

Measurements of volume change on compression of phosphorus pentoxide showed a reversible phase transition. Pressure—volume curves, obtained by a difference method, showed a marked hysteres the forward transition requiring from 1600 to 2700 kg/cm^2 greater pressure than the reverse, depending on the temperature. X-ray diffraction studies at high pressure confirmed the findings. The crystal form of the new modification has not yet been determined.

20399 VACUUM SINTERING OF QUARTZ POWDER AND PHASE TRANSFORMATION OF QUARTZ. Y.Moriya.
Vacuum (GB), Vol. 11, No. 3, 158-72 (1961).

The process of the phase transformation of quartz to silica glass in the range of heating time 10-120 min at a pressure of 10^{-5} torr is as follows: (a) at a heating temperature below about 1700°C, quartz → silica glass → cristobalite; (b) at a heating temperature above about 1700°C, quartz → silica glass. Quartz transforms to silica glass from the surface of the quartz crystal. Since the surface of the material in general has no definite structur the transformation temperature of quartz to silica glass ought to be considered indefinite. An experiment using −60 mesh quartz powde indicated that sintering was produced by the surface tension of silica glass which appeared on the quartz surface. The silica glass concentration was $> 25\%$, and the heating temperature was above about 1600°C. It is recognized that H_2O is discharged from the quartz during the process of deformation of the quartz lattice by heat. The H_2O content in the quartz used in the experiment was probably $< 0.1\%$.

PHASE TRANSFORMATION IN THIN Ni FILMS DUE TO NEUTRON BOMBARDMENT. See Abstr. 19822

CRYSTALLOGRAPHY

20400 REPLACEMENT BY POINTS [PONCTUALISATION] OF CHARGES IN CRYSTAL STRUCTURES OF IONIC TYP
J.D.H.Donnay and G.Donnay.
C.R. Acad. Sci. (France), Vol. 253, No. 2, 291-2 (July 10, 1961).
In French.

The morphology of $BaSO_4$ is discussed in terms of a generalization of the idea of point charges. See Abstr. 10057 of 1959; 7860, 11571 of 1961. A.R.Stoke

20401 PLOTTING TENSORS OF A GIVEN SYMMETRY.
Yu.I.Sirotin.
Kristallografiya (USSR), Vol. 6, No. 3, 331-40 (May-June, 1961).
In Russian.

A method is shown for plotting tensors of a given internal and crystallographic symmetry. The required tensor is plotted in the form of a linear combination of some basic tensors, the coefficient for which are invariants, directly characterizing its anisotropy. Tensors of a fairly high symmetry are especially readily plotted; thei notation is considerably simplified and calculations with them are facilitated. [English translation in: Soviet Physics—Crystallography (USA), Vol. 6, No. 3, 263-71 (Nov.-Dec., 1961)].

20402 CLASSIFICATION OF SYMMETRY GROUPS.
W.T.Holser.
Acta cryst. (Internat.), Vol. 14, Pt 12, 1236-42 (Dec. 10, 1961).

Point groups and space groups in 3-D are two classes of symmetry groups which have proved most useful in crystallograph ntly other sorts of groups have been described involving a ge of "side", sign (antisymmetry), or colour, and some of these already been applied to problems of twinning and magnetic tures. A uniform classification of these various groups should in visualizing the relationships among them and in working ew applications. If all variables are treated geometrically, ding antisymmetry, symmetry groups may be classed according e dimensions of space that are invariant under their operations. the 80 "antisymmetry groups in a plane" have 2-D and 3-D es invariant. The group is "in" the highest dimensional space variance, and translations are allowed only in the lowest ensional space. But spaces of intermediate dimensions may be invariant; the 31 "Streifenornamente" have 1, 2, 3 spaces riant. Alternatively these classes may be described by the metry of the invariant space, using the continuous translations rotations. Thus the class of groups in 2, 3 space are all the stallographic subgroups of t∞/mm, and class 1, 2, 3 are all roups of tmmm. All such classes through 4-D are tabulated.

0403 TWINNING IN A CATION-DEFICIENT SPINEL STRUCTURE. J.Goodyear and G.A.Steigmann.

c. Phys. Soc. (GB), Vol. 78, Pt 4, 491-5 (Oct., 1961).

Crystals of β-In_2S_3 were studied under the polarizing micro- pe and by X-ray diffraction. Optical examination showed that the stals are twinned, and the relative orientations of the twin ponents were determined by rotation and oscillation X-ray tographs. The diffraction data also confirmed the body- tred tetragonal cell proposed by Rooymans (1959). Assuming the material has a spinel structure, deficient in cations, it ows that twinning takes place when a redistribution in the ahedrally occupied sites occurs.

20404 THE INTERFACIAL ENERGY OF COHERENT TWIN BOUNDARIES IN COPPER. M.C.Inman and A.R.Khan.

l. Mag. (GB), Vol. 6, 937-8 (July, 1961).

Intersections of coherent twin boundaries with grain boundaries hin films of o.f.h.c. copper were examined with an electron croscope and the true dihedral angles of intersection were asured. The ratios γ_t/γ_G show strong clustering about a mean 0.02. D.G.Holloway

20405 TWINNING IN GRAPHITE.

E.J.Freise and A.Kelly.

c. Roy. Soc. A (GB), Vol. 264, No. 1317, 269-76 (1961).

The twins are regions misoriented from the crystal by a ation of 20° 48′ about a direction in the basal plane. The twin ndaries are shown to be simple tilt boundaries of a particular le. As well as twins, bend planes of varying angle are also erved in graphite crystals. The dislocation structure of the n boundary is deduced and the effect of twins on the mechanical perties of graphite crystals is considered.

20406 EQUILIBRIUM DEGREES OF CRYSTALLIZATION PREDICTED FOR "SINGLE PASS" AND FOLDED IAIN CRYSTALLITE MODELS.

J.Roe, K.J.Smith, Jr and W.R.Krigbaum.

chem. Phys. (USA), Vol. 35, No. 4, 1306-11 (Oct., 1961).

The free energy change for the crystallization of a bulk polymer nsists of two parts: the "single crystal" term exhibited by low lecular weight compounds, and that arising from the deformation oduced in the intervening amorphous chains as crystallization oceeds. The latter term limits the degree of crystallinity which n be achieved in polymeric material at a given temperature. ginning with an initially unstretched, isotropic sample, the entropy ange associated with the deformation of the amorphous chains is lculated for two models, in which the chain either passes through crystallite once and departs, or folds back and forth within the ystallite several times before re-entering the amorphous region. e folded chain morphology imposes less strain upon the amorphous ains, and hence results in the development of higher degrees of ystallinity from the original isotropic melt. The folded chain odel, in which the amorphous portions are represented by flexibly nked chains, gives good agreement with the observed equilibrium grees of crystallinity, for high molecular weight fractions of lyethylene, over a considerable temperature range. An approxi- ate treatment is also given for the molecular weight dependence of ystallinity at a fixed temperature.

20407 SURFACE DETACHMENT FROM POLYETHYLENE CRYSTALS. D.C.Bassett.

hil. Mag. (GB), Vol. 6, 1053-6 (Aug., 1961).

The crystal surface is covered with carbon by evaporation and the main part of the crystal is subsequently dissolved away leaving a detachment replica. Detailed instructions for the preparation are given and the results of electron diffraction experiments are shown. C.A.Hogarth

20408 STEEP-SIDED TRIGONS ON DIAMONDS.

E.M.Wilks.

Phil. Mag. (GB), Vol. 6, 1089-92 (Sept., 1961).

The natural octahedron surfaces of diamond exhibit many small triangular-shaped cavities or trigons. The majority are low-angle pyramids, but there is another variety which has steep sides and a flat base. Contour measurements on the pyramidal form have already been reported (Abstr. 6369 of 1959); similar measurements have now been made on the steep-sided variety. It is found that the sides of these trigons are octahedron planes. Thus the steep-sided trigons must arise by some quite different mechanism from the etch process responsible for the low-angle pyramids.

FRINGES ON MgO CRYSTAL FACES OBSERVED BY AN ELECTRON MICROSCOPE. See Abstr. 20714

20409 STRUCTURE OF ETCH-PITS ON DIAMOND SURFACES.

A.R.Patel.

Physica (Netherlands), Vol. 27, No. 12, 1097-1100 (Dec., 1961).

The etch-pits formed on octahedral cleavages of diamonds were studied optically. Three types of pits were observed: (a) point bottomed pits (b) flat bottomed pits and (c) terraced pits. It is established that, though their shape is the same, structures differ. Eccentricity is observed in case of point bottomed and flat bottomed pits and is explained by postulating inclined linear dislocation lines in the body of the crystal. The implications are discussed.

20410 THEORY OF LINEAR FACET GROWTH DURING THERMAL ETCHING. W.W.Mullins.

Phil. Mag. (GB), Vol. 6, 1313-41 (Nov., 1961).

Under certain conditions, a planar metal surface will develop linear facets, or planar strips inclined to the original surface and meeting it along sharp cusp lines (e.g. Ag heated in air). A discussion is given, in terms of the Wulff plot, of the energetic conditions under which linear facets form. A theory is then developed, subject to certain simplifying assumptions, of the progressive widening of the facets under the separate action of evaporation—condensation and of surface diffusion. Order-of-magnitude calculations are also given for the case of volume diffusion. Facet profiles and their characteristic time laws of growth are calculated. In the case of surface diffusion, the theoretical results depend upon a parameter equal to the ratio of the surface diffusion coefficient on the facet plane to that on the general complex surface. Comparison with experiment should permit determination of this parameter as well as other interesting information.

20411 LIGHT FIGURES AND SURFACE STRUCTURES REVEALED BY CHEMICALLY ETCHED GERMANIUM SINGLE CRYSTALS. M.Yamamoto, J.Watanabé and K.Hoshi.

Sci. Rep. Res. Insts. Tohoku Univ. A (Japan), Vol. 12, No. 6, 471-85 (Dec., 1960).

Light figures projected on a screen from germanium single crystals, polished mechanically and etched with various chemical reagents, were examined in order to find out light figures or etching directions suitable for orientation determination. Information regarding surface structures of germanium single crystals developed by mechanical polishing and by chemical etching was obtained from the analysis of the observed light figures and from microscopic observations of crystal surfaces. It was found that distinct light figures suitable for the orientation work were obtained by a brief etching with concentrated nitric acid plus water (1 : 1 and 3 : 7; 70°C), with concentrated nitric acid plus water plus hydrofluoric acid plus silver nitrate (45 ml + 45 ml + 10 ml + 50 or 20 mg, and 20 ml + 40 ml + 40 ml + 2 g), with hydrofluoric acid plus hydroperoxide plus water (1 : 1 : 4), and with 30% hydroperoxide (100°C). Among these etchants, hydrofluoric acid plus hydroperoxide plus water (1 : 1 : 4) is most suited for accurate orientation determination. Generally, crystal faces developed by etching were found to be those belonging to the principal crystal zones, but dilute nitric acid heated at 70°C developed some additional high-index crystal faces belonging to a high-index crystal zone. There was a tendency for low-index crystal faces to appear by a brief etching and high-index ones by prolonged etching. Relatively clear light figures were obtained on germanium crystals when polished with silicon carbide powder.

20412 LIGHT FIGURE PHENOMENA REVEALED AND CRYSTAL FACES DEVELOPED BY CHEMICAL ETCHING IN SILICON CRYSTAL.

M.Yamamoto, J.Watanabé, K.Masumoto and T.Kawada.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 3, 226-34 (June, 1960).

The light-figure phenomenon of silicon single crystals etched with various chemical reagents was studied in order to find out the light figures or the etching condition appropriate for orientation determination, and to obtain information regarding crystal faces developed by etching. The etching with aqueous solutions of KOH and of NaOH, boiled or heated at 100° or 70°C, produces distinct $\{100\}$, $\{110\}$, and $\{111\}$ light figures, while any other oxidizable reagent reveals only indistinct light figures or no light figure at all. It was found that, for orientation work, etching with saturated aqueous solutions of KOH and of NaOH, heated to about 100°C, is most suitable in view of the shortness of the required etching time ($< 2 \sim 3$ minutes). The crystal faces developed by etching with alkaline reagents depend on the kind, concentration, and temperature of the reagent as well as on the time of etching, and they belong to the $\langle 100\rangle$ and $\langle 110\rangle$ zones, the $\{111\}$ and $\{100\}$ faces being commonly developed.

20413 DETERMINATION OF THE SCREW-DIRECTION OF TELLURIUM SINGLE CRYSTALS FROM CHEMICAL ETCHES. K.Herrmann.

Phys. Status solidi (Germany), Vol. 1, No. 3, 254-6 (1961).
In German.

Cleaved faces of tellurium single crystals were etched in concentrated sulphuric acid. There appear to be two types of crystals, the etch figures (hillocks and pits) of one type being reflected images of those of the other type. The symmetry of these etch figures defines a screw-direction. It is suggested that the two observed types indicate the presence of right-turning and left-turning Te.

20414 THE RELATION BETWEEN ETCH PITS AND THE PURITY OF NaCl SINGLE CRYSTALS.

D.K.de Grinberg and A.Grinberg.
Czech. J. Phys., Vol. 11, No. 8, 609-10 (1961).

From etching experiments using $HgCl_2$ in C_2H_5OH, a relation between etch pit density and Cu-impurity content is deduced.

C.A.Hogarth

20415 AN ELECTRON MICROSCOPE STUDY OF THE STRUCTURE OF ZINC SINGLE CRYSTALS.

P.Kratochvíl and M.Molčík.
Czech. J. Phys., Vol. 11, No. 7, 540-1 (1961).

Zinc single crystals of 99.997% purity were polished, and etched in a 6.5% nitric acid solution for 30 sec to make their dislocations visible. The surface structure was examined in an electron microscope by means of two-stage carbon replicas shadowed with AuPd alloy. After etching, etch pits appeared on the crystal lamellae at a density of 10^8 cm^{-2}. A more detailed study is needed to indicate their origin, but the observed density agrees with the dislocation density to be expected in such zinc crystals.

R.V.Coates

DISLOCATIONS IN CRYSTALS GROWN FROM THE MELT.
See Abstr. 19780

PREPARATION OF ALLOYED MONOCRYSTALS AND P—N JUNCTIONS IN ALUMINIUM ANTIMONIDE. See Abstr. 19865

20416 A NOTABLE GROWTH SPIRAL ON SYNTHETIC DIAMOND. S.Tolansky.

Nature (GB), Vol. 190, 992 (June 10, 1961).

A description is given of an exceptionally well defined growth spiral of height 1300 A, found on the cubic face of a synthetic diamond, grown by De Beers of Johannesburg. The spiral is illustrated, both by phase contrast microscopy and by interferogram, by which the height was evaluated.

S.Tolansky

20417 MICROSCOPE OBSERVATIONS OF CRYSTALS APPEARING IN THE PROCESS OF COOLING AQUEOUS SOLUTIONS OF ALCOHOLS. K.Yamaji.

J. Phys. Soc. Japan, Vol. 16, No. 10, 2045-55 (Oct., 1961).

The crystals growing from aqueous solutions of alcohols (methanol, ethanol, iso-propanol, n-propanol, ethylene glycol, propylene glycol, and glycerol) were photographed with ordinary and cine (16 mm) cameras through a microscope. The sample was cooled by the use of liquid oxygen (or nitrogen). The temperature measured by thermocouples were recorded automatically. Cryst forms were classified into two main groups; hexagonal and cubic. To the former belong hexagonal fernlike crystals, "soft" hexagon plates, and "soft" spherical crystals, and to the latter cubic cryst that appear only in ethanol, n-propanol, and iso-propanol solution Among the cubic crystals, only the one appearing in iso-propanol solution was found to show double refraction at temperatures bel $-51^\circ \sim -52^\circ$C. Phase transition does occur in the crystal. The crystal systems below and above the transition temperature are most probably tetragonal and cubic, respectively, as inferred fro the analogy of similar phase transition in metals and other substances. The results of centrifugal precipitation and the similari in crystal form to snow indicate that the constituent of hexagonal crystals may well be assumed as ice. What the cubic crystal consists of remains as yet unknown, though the fact that various concentrations and cooling speeds always lead to phase transition at the same temperature gives a positive proof of the definite proportion of constituents (alcohol and water). The growing speed of cubic crystals is much faster than that of hexagonal crystals, which also seems to suggest that the constituents of cubic crystals are the associated molecules of water and alcohol.

20418 INVESTIGATION OF A METHOD OF GROWING CRYSTALS OF GaP AND GaAs FROM THE VAPOUR PHASE. G.R.Antell.

Brit. J. appl. Phys., Vol. 12, No. 12, 687-90 (Dec., 1961).

Crystals of GaP and GaAs were grown from the vapour at abo 900°C using an iodide process. The crystals were deposited on a localized cold spot and their initial growth could be readily observ Single crystals samples of GaP had resistivities of the order of 5×10^9 ohm cm. The concentration of iodine in the GaP crystals was found to be less than 2 parts in 10^8. A p-type sample of GaAs was grown at less than 800°C which had a Hall coefficient of 53 cm^3 $coulomb^{-1}$.

IMPURITY STRIATIONS IN UNROTATED CRYSTALS OF InSb.
See Abstr. 17519

20419 THE GROWTH OF ICE CRYSTALS ON FRESHLY CLEAVED COVELLITE SURFACES. J.Hallett.

Phil. Mag. (GB), Vol. 6, 1073-87 (Sept., 1961).

Oriented ice crystals growing as thin plates on freshly cleaved surfaces of covellite, when examined by reflected light, show interference colours which give a measure of the crystal thickness. Some growing crystals remain constant in colour, failing to thicken in a direction normal to the basal plane. Growth can be initiated on t basal plane by contact with a thicker crystal, by increase of the excess vapour density, or by causing mechanical damage to the surface. Whe two crystals of different thickness touch, layers grow from the point of contact across the thinner crystal, with velocity inversely proportional to the thickness, for thickness 200 to 1000 A. This implies that the layers are growing primarily by surface diffusion of adsorbed molecules to their edges. This surface diffusion is characterized by a distance x, from which a growing layer collects molecules; measurements indicate that x has a maximum value of $7.5\,\mu$ at -6°C. The shapes of layers and crystals are circular, polygonal, or dendritic depending on their thickness, and the excess vapour density of the environment. The relevance of the results to the variation of ice crystal habit with temperature is examined.

THE GROWTH OF SNOW CRYSTALS AT LOW SUPER-SATURATIONS. See Abstr. 20831

20420 THE PREPARATION OF FINE POWDER HEXAGONAL Fe_2C AND ITS COERCIVE FORCE.

W.D.Johnston, R.R.Heikes and J.Petrolo.
J. phys. Chem. (USA), Vol. 64, No. 11, 1720-2 (Nov., 1960).

The relatively rare hexagonal form of Fe_2C was prepared in fine powder form by the reaction of a gaseous mixture of H_2 and CO with Raney iron at 240°. The occurrence of the hexagonal form appears to require the exclusion of Fe_3O_4. If Fe_3O_4 is present, the carbide is found in the more common Hägg form. The coercive force of the fine powder hexagonal Fe_2C prepared by this method is approximately 800 Oe.

20421 THE EFFECTS OF A TEMPERATURE GRADIENT IN THE OVEN ON THE IMPURITY DISTRIBUTION IN TH GROWING CRYSTAL. V.Ya.Khaimov-Mal'kov and V.A.Perl'shtei

Kristallografiya (USSR), Vol. 4, No. 6, 904-7 (Nov.-Dec., 1959).
In Russian.

The KI—TlI system has been used to study the effects of a te erature gradient in the oven on the transfer of the trace c ponent within the melt and on the exchange process at the g th front. It is found that the transfer is convective if the g ient is large, and diffusive if the gradient is small. The p ition coefficient decreases as the gradient increases. [English t slation in: Soviet Physics—Crystallography (USA), Vol. 4, N 6, 857-60 (June, 1960)].

0422 MARKOFF CHAIN MODEL FOR GROWTH OF POLYMER SINGLE CRYSTALS. F.P.Price.

hem. Phys. (USA), Vol. 35, No. 5, 1884-92 (Nov., 1961).

A theory is presented wherein the development of a polymer s le crystal is envisioned as the successive coherent addition of l ers of segments of polymer molecules, each layer acting as the s strate for the succeeding layer. The substrate is assumed s oth and the distribution of segment lengths in the next layer is a umed to be controlled by equilibrium considerations. The t ory predicts that as the supercooling is increased the energy g ned due to the bulk energy of crystallization tends to overwhelm t energy lost due to formation of new surfaces. This has the ult of making the average segment length of the adding layer c ser and closer to the substrate length. In some cases it even eeds the substrate length. The net result is that the tempera- e dependence of ultimate crystal thickness is not as great as was lied by the $(\Delta T)^{-1}$ laws of previous theories. The theory has n satisfactorily fitted to the experimentally observed dependence temperature of single crystals of linear polyethylene grown m dilute xylene solution. The parameters used to fit theory to eriment are a lateral surface energy of 13.3 ergs/cm^2, an end d surface) energy of 110 ergs/cm^2, and a solution temperature 113°C. The theory also indicates that the surface of the poly- ylene crystals is remarkably smooth with an average roughness only one to two angstroms. Predictions are also made concerning profile of a single crystal in the region of its primary nucleus ntral region). It is shown that hollows, sharp spikes, or flat ped mesas of considerable extent may be observed depending on supercooling.

20423 ISOTHERMAL CRYSTALLIZATION KINETICS OF POLYETHYLENE. III. INFLUENCE OF THE MPLE PREPARATION. J.Rabesiaka and A.J.Kovacs.

appl. Phys. (USA), Vol. 32, No. 11, 2314-20 (Nov., 1961).

Isothermal crystallization in bulk was compared dilatometrically th linear polyethylene samples which had been moulded in different ys, including melt orientation and the sintering of precipitated wders from dilute solutions. These experiments show significant fferences in the crystallization kinetics, which in some cases can- t be removed even by prolonged prior heating of the melt. The ta were analysed by an empirical expression in terms of nuclea- on and growth processes, according to the theoretical approach of rami. The result suggests that, in general, the melted poly- hylene is not in a true thermodynamic equilibrium and includes me "quasi-indestructible" clusters, which act as heterogenous clei in the crystallization process. The nature and the quantity these nuclei depend on the moulding, melting and mechanical story of the sample, so that the structure of the semicrystalline aterial may exhibit a wide variety.

20424 RATE OF RECRYSTALLIZATION OF POLYETHYLENE SINGLE CRYSTALS. W.O.Statton.

appl. Phys. (USA), Vol. 32, No. 11, 2332-4 (Nov., 1961).

Platelet crystals of linear polyethylene recrystallize extremely apidly when immersed in a bath of a hot liquid such as ethylene lycol, glycerine, or Woods metal. This recrystallization proceeds t a much faster rate and to greater extent than when the heating medium is air. For example, heating in the liquids at 127°C causes he length of the chains between folds to increase 50% in 1 sec; the ltimate increase of 200% occurs in about 10 sec. No definite explan- tion is presently apparent for this much faster rate and greater xtent in liquids. No evidence is found for reversibility when nnealed crystals are reheated at a lower temperature.

20425 ON THE THEORY OF POLYMER CRYSTALLIZATION. F.C.Frank and M.Tosi.

Proc. Roy. Soc. A (GB), Vol. 263, 323-39 (Sept. 19, 1961).

The systematic pleating of polymer molecules in their crystallization, in segments of a length of the order of 100 A, which depends on the crystallization temperature, is interpreted in terms of the kinetics of crystal growth. The theory begins with but departs from a theory proposed by Lauritzen and Hoffman (Abstr. 8161 of 1960), in which the statistical probability of a bend occurring somewhere gives a factor disfavouring long segments, and the probability of a deposited chain coming off again gives a factor disfavouring short segments, the two defining an optimum segment length. A basic analysis of "nucleation theory" is included in this paper (and in an appendix) to clarify the points of departure. Whereas the Lauritzen—Hoffman theory postulates that successive fold segments are of the same length as the first on a crystal face, this paper shows that there must be considerable fluctuation in length from segment to segment. An approximate calculation of these fluctuations indicates that (within a specific range of supercoolings) there is a characteristic segment length l^* such that after shorter segments than l^* the next fluctuation is likely to be to a longer one, and after longer segments than l^* the next fluctuation is likely to be to a shorter one: so that l^* defines a stable mean strip-width into which the chain molecule folds. The next strip of crystal deposited on this one has a narrower corresponding stable width. With successive strips depositing on each other, within a certain specific range of supercooling, the strip widths converge to a stable value l^{**}, with depends on temperature in the observed manner. For smaller supercoolings the strip width converges to a value too narrow for any further growth to occur. At larger supercoolings multiple nucleation of crystals within the same molecular chain is considered to change the mode of crystallization — dendrites rather than tabular crystals are in fact observed at the lower temperatures. Though the theory is aproximate, acceptable parameters give satisfactory agreement with observation.

20426 GROWTH OF CRYSTALS FROM MOLTEN CROSS-LINKED ORIENTED POLYETHYLENE.

J.T.Judge and R.S.Stein.

J. appl. Phys. (USA), Vol. 32, No. 11, 2357-63 (Nov., 1961).

The growth of crystals from the melt in oriented, crosslinked polyethylene was studied by X-ray diffraction and birefringence as a function of orientation. It was found that for samples elongated more than about 200%, the crystals grow with their c axes parallel to the stretching direction. At elongations less than 200%, there is a rather abrupt transition to a mode of growth in which the b axis is perpendicular to the stretching direction, with a tendency for the a axis to be aligned parallel to this direction. An interpretation is made in terms of the folded-chain concept of crystal structure.

20427 THE PREPARATION AND SOME PROPERTIES OF METALLIC SCANDIUM.

V.I.Spitsȳn, L.N.Komissarova and A.A.Men'kov.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 4, 903-6 (Aug. 1, 1961).

In Russian.

Metallic scandium was prepared from $SnCl_3$ produced by heating together a mixture of scandium oxide and sugar carbon. The powdered metal produced in this way was heated to 600° in vacuum, after being compressed to a tablet at a pressure of 100 kgm cm^{-3}. The resultant metal has a lustrous silvery appearance with a yellow cast. X-ray investigations indicate an hexagonal structure with $a = 3.302 \pm 0.005$ A and $c = 5.255 \pm 0.005$ A. The X-ray density is 2.992 gm cm^{-3} and that determined with a pycnometer 3.0 gm cm^{-3}. The microhardness of $> 99\%$ pure scandium is 75 ± 5 kgm cm^{-3} and the compressibility 25-30 kgm cm^{-2} for 97-97.5% material. K.N.R.Taylor

20428 FORM OF THE CRYSTALLIZATION FRONT OF SINGLE SEMICONDUCTING CRYSTALS, PRODUCED FROM THE MELT BY THE CZOCHRALSKI METHOD.

M.G.Mil'vidskii and B.I.Golovin.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1015-18 (April, 1961).

In Russian.

A formula based on the thermal conditions during crystallization is obtained for the velocity with which the growing crystal should be withdrawn in order to maintain a plane front of crystallization. Results on the production of silicon crystals give good agreement with the formula. [English translation in Soviet Physics—Solid State, (USA), Vol. 3, No. 4, 737-9 (Oct., 1961)]. R.F.S.Hearmon

20429 AN ELECTRON MICROSCOPIC STUDY ON THE CRYSTAL GROWTH OF SILVER EVAPORATED ON MOLYBDENITE. Y.Kamiya and R.Uyeda.

Acta cryst. (Internat.), Vol. 14, Pt 1, 70 (Jan., 1961).

20430
RECRYSTALLIZATION OF DEFORMED ALPHA-URANIUM SINGLE CRYSTALS.
L.T.Lloyd.

J. nuclear Materials (Internat.), Vol. 2, No. 2, 141-6 (June, 1960).

The orientation relationship between deformed and recrystallized α-uranium can be expressed as 27.5° rotations about axes located 70.0° from the [100], 63.5° from the [010] and 34.0° from the [001]. In deriving this relationship it was necessary to consider the recrystallized grains found upon annealing deformed single crystals as originating from twins as well as from the parent crystal. Comparisons of deformation and recrystallization textures of polycrystalline uranium agree well with the finding.

20431
GROWTH HABIT OF ELECTRODEPOSITED URANIUM DIOXIDE SINGLE CRYSTALS.
R.G.Robins.

J. nuclear Materials (Internat.), Vol. 2, No. 2, 189-90 (June, 1960).

Single crystals of uranium dioxide up to 50 mg in weight were deposited on a platinum cathode by electrolysis of a solution of uranyl chloride in a fused sodium chloride—potassium chloride eutectic. The crystal habit was octrahedral. Changes in growth faces with increase in mass are reported. Deviations from stoichiometry up to $UO_{2.15}$ had no effect on the growth process.

J.Holt

20432
GROWTH RATES OF ZINC CRYSTALS FROM THE VAPOR PHASE.
R.L.Parker and L.M.Kushner.

J. chem. Phys. (USA), Vol. 35, No. 4, 1345-8 (Oct., 1961).

The rate of growth of zinc crystals from the vapour phase was studied as a function of the vapour supersaturation σ at a temperature of 390°C. The σ values ranged between 0.009 and 0.09. The rate R was found to vary approximately linearly with σ, permitting estimates to be made of the two parameters σ_1 and βC_0, appearing in the Burton, Cabrera, and Frank theory of crystal growth. The results indicate that surface nucleation was not operative in either the nucleation or the growth of these crystals.

20433
PREPARATION OF SINGLE CRYSTALS OF $Zn_x Cd_{1-x} Sb$ BY INTERRUPTION OF FREE CRYSTALLIZATION OF THE MELT.
K.Šmirous.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 170-1 (April, 1961).

Single crystal platelets are prepared by allowing partial crystallization of a melt and then by sucking away the remaining approximately 85% liquid by means of a vacuum system. The composition is determined by the temperature of the melt.

C.A.Hogarth

20434
ON THE GROWTH OF ZnS CRYSTALS.
J.Nishimura.

Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 4, 384-400 (Aug., 1960).

Growth of ZnS crystals was observed in relation to temperature and temperature gradient. When crystals grow in a steep temperature gradient zone, growth advances by following three stages: (i) needle crystals grow to the direction of temperature gradient along c-axes; (ii) these crystals assemble themselves into several bundles with their lateral faces adjoining to each other; (iii) a polycrystal with grains, which are assemblies of the needle crystals, grows into a single crystal or a polycrystal with larger grains, releasing grain boundary energy. When temperature gradient is not steep and temperature is high, grain growth progresses faster than the growth by vapour deposition, and the grains become large in the lateral direction. However, as the grains grow in this case with c-axes tending to various directions and the surface tensions of the grain boundaries are in balance, a polycrystal with moderate-sized grains grows. Therefore, for obtaining large single crystals it is necessary for the crystals to grow in the zone where the temperature is not only high enough to advance grain growth but the temperature gradient is steep. Comparison with growth by the Reynolds method (Abstr. 9100 of 1950) was also described.

20435
RAPID METHOD OF GROWING SINGLE CRYSTALS OF Al AND ITS ALLOYS BY RECRYSTALLIZATION.
Yu.A.Bagaryatskii and E.V.Kolontsova.

Kristallografiya (USSR), Vol. 4, No. 6, 935-6 (Nov.-Dec., 1959). In Russian.

A modified strain—anneal method is described. Single crystals of Al—4% Cu, Al—3% Cu—1% Mg, Al—10% Zn and commercial purity Al were produced in wire by introducing a few per cent of strain and annealing below the recrystallization temperature before giving the final recrystallization anneal. The specimens varied in length from 150 mm for Al to about 5 mm for the Al—Zn alloy. The technique was modified further for high purity (99.99%) Al. The initi anneal involved heating the specimen in 3 hr up to 450° C where i was held for up to 10 hr before the final treatment of a 4 hr anne at 600° C. [English translation in: Physics—Crystallography (USA), Vol. 4, No. 6, 892-4 (June, 1960)].

A.E.

20436
SYNTHESIS AND X-RAY ANALYSIS OF DIAMOND.
H.L.D.Pugh and J.Lees.

Nature (GB), Vol. 191, 865-7 (Aug. 26, 1961).

A brief description is given of a high pressure cell used for the production of synthetic diamond. Temperature and pressure calibrations are described. One synthetic diamond, black, 0.3 × 0.3 × 0.4 mm is illustrated. X-ray pictures are described and lattice parameters are discussed.

S.Tolans

20437
SUPERCOOLING IN A MELT AND THE GROWTH OF CRYSTALS BY THE CZOCHRALSKI METHOD.
D.A.Petrov and A.A.Bukhanova.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 4, 933-5 (Aug. 1, 1961). In Russian.

Crystals of aluminium containing 10^{-4}% copper were grown without rotation at pulling speeds of 2 mm/min. An asymmetrica growth front was established due to asymmetrical supercooling in the melt. Etching showed that a greater degree of supercooling caused an increase in the copper concentration, and a decrease in crystal perfection. During growth the effect of rotating the crystals by 180° was studied. Continuous rotation produced ridge on the sides of crystals and these corresponded with slower ratio of growth and uptake of copper. The authors conclude that the growth of homogeneous crystals requires a symmetrical temperature distribution. [English translation in: Soviet Physics—Doklady (USA)].

D.J.Barb

20438
THE CRYSTALLIZATION OF Bi, Te AND Bi_2Te_3 BY MEANS OF THE PELTIER EFFECT.
S.A.Semenkovich, L.A.Kolomoets and N.V.Kolomoets.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1597-600 (May, 1961). In Russian.

The movement of the liquid—solid interface in a horizontal partially-molten ingot was investigated under the action of a constant current normal to the interface. Ioffe has shown that und these conditions the Peltier effect produces movement of the inter face. Using Ioffe's formula, measurements of interface velocity, under nearly isothermal conditions, give Peltier coefficients for Bi, Te and Bi_2Te_3 of -0.012, +0.16 and -0.016 respectively. Reaso are proposed for the existence of stable growth fronts. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1159-61 (Nov., 1961)].

D.J.Barb

20439
THE PRODUCTION OF DOUBLE CRYSTALS OF INDIUM ANTIMONIDE AND GALLIUM ANTIMONIDE.
V.I.Ivanov-Omskii, N.K.Kiseleva and B.T.Kolomiets.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1621-2 (May, 1961). In Russian.

Using the Czochralski technique, double crystals are formed by seeding indium antimonide with large crystals of the isomorph gallium antimonide. Any grain boundaries in the seed crystal are faithfully preserved in the pulled material. [English translation in Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1175-6 (Nov., 196

D.J.Barb

20440
SYNTHESIS AND SOME PROPERTIES OF SINGLE CRYSTAL MgAl FERRITES.
M.V.Rozhdestvenskaya, O.S.Romanovskaya and E.K.Yur'eva.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2342-5 (Aug., 1961). In Russian.

The conditions for synthesis of MgAl ferrites by the Verneuil method (Abstr. 6327 of 1960), and by crystallization from the fused solvent are investigated. The Verneuil method gives single-crystal boules of MgAl ferrite with diameter about 5mm and lengt 20-30 mm. Crystallization from the fused solvent gives octahedra single crystals of $MgFe_2O_4$, 2-4 mm in size. Chemical, X-ray, and ferromagnetic resonance data are also given. See also following abstract. [English translation in: Soviet Physics—Solid State (USA)].

R.F.S.Hearm

20441
THE QUESTION OF INVESTIGATING SINGLE CRYSTALS IN THE SYSTEM $MgO—MnO—Fe_2O_3$, SYNTHESIZED BY THE VERNEUIL METHOD.
M.V.Rozhdestvenskaya.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2346-9 (Aug., 1960).

In ssian.
See previous abstract. The conditions for synthesis of si e crystals in the system MgO—MnO—Fe_2O_3 are investigated. La e single crystal boules with diameter 8-10 mm and length ab t 100 mm are obtained. The composition of the crystals pr tically coincides with the theoretical composition. Chemical, X y and ferromagnetic resonance data are also given. [English slation in: Soviet Physics—Solid State (USA)].

R.F.S.Hearmon

0442 THE GROWTH OF ZINC SULPHIDE SINGLE CRYSTALS FROM FLUX. Y.Mita.

hys. Soc. Japan, Vol. 16, No. 7, 1484 (July, 1961).

Attempts were made to grow single crystals of zinc sulphide of onsiderable size using sodium chloride as solvent flux. The a ratus used is described. Most crystals were needle-like with m imum size about 10 mm in length and 0.2 mm in diameter. X ay, spectroscopic and optical investigations are briefly reported.

H.E.Schmid

0443 THE GROWTH OF SINGLE CRYSTALS OF BINARY AND TERNARY CHALCOGENIDES BY CHEMICAL TRANS- RT REACTIONS. R.Nitsche.

hys. Chem. Solids (GB), Vol. 17, No. 1-2, 163-5 (Dec., 1961).

Crystals of twelve different chalcogenides were grown in a perature gradient using I_2 as transporter. The temperatures d and the crystal forms and sizes obtained with each compound a tabulated.

D.G.Holloway

20444 GROWING OF SINGLE CRYSTALS OF ZINC, BISMUTH, AND WHITE TIN BY THE BRIDGMAN METHOD.

Yamamoto and J.Watanabe.

. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 6, 486-99 c., 1960).

The effects were studied of various growing conditions on the ld percentage as well as orientation distribution of round-bar gle crystals of zinc, bismuth, and white tin as grown by the idgman method. In order to prepare the ingots which are to be nverted into single crystals, molten zinc was poured in air or in uum or sucked up into soft glass tubes, and it was found that vacuum casting is not practical and the suction casting is tter. The higher the purity of the material, the greater is the gree of success. The percentage yield falls very much when melted zinc is used. It was found, from the experiments on the oduction of single crystals from ingots made by sucking up, that, th increasing speed of lowering the crucible, the percentage yield creases approximately linearly for zinc and white tin single ystals and approximately exponentially for bismuth single crystals. espective of the speed of lowering of the crucible, zinc single ystals with the angle θ which the rod axis makes with the c axis the range from 75° to 85° are preferentially obtained, and bis- uth single crystals with $\theta \geq 70°$ are grown most easily, while bis- uth single crystals with $\theta = 10 \sim 40°$ are difficult to grow. In ite tin single crystals, the [110] direction predominates at fast wering rate of the crucible. Single crystals of any orientation e produced at low lowering speeds, while those of small θ are rdly obtained at higher lowering speeds. The purity of the aterials does not seem to affect the orientation distribution.

20445 A DISCUSSION OF THE GROWTH AND EVAPORATION OF POTASSIUM WHISKERS. S.J.Hruska and J.P.Hirth.

. Elektrochem. (Germany), Vol. 65, No. 5, 479-81 (1961).

A modified interpretation of the experimental results of Dittmar d Neumann (1960) on growth of potassium whiskers is presented. his interpretation does not affect their mathematical analysis of e problem of whisker growth by a diffusion mechanism, but does ffect the parameters determined from their mathematical analysis. lso, the interpretation shows that Dittmar and Neumann's results re consistent with current theories of crystal growth. See also llowing abstract.

20446 REMARKS ON THE CONTRIBUTION OF S.J.HRUSKA AND J.P.HIRTH ON GROWTH AND EVAPORATION F POTASSIUM WHISKERS. W.Dittmar and K.Neumann.

. Elektrochem. (Germany), Vol. 65, No. 5, 481-2 (1961). German.

A short reply by the original authors (see preceding abstract).

D.G.Holloway

20447 INFLUENCE OF THE ELECTRIC FIELD ON THE SILVER AND IRON WHISKERS GROWTH.

T.Hoffmann, J.Mazur, J.Nikliborc and J.Rafałowicz.
Brit. J. appl. Phys., Vol. 12, No. 11, 635-6 (Nov., 1961).

Studies the influence of an electric field on the silver and iron whiskers growth obtained by Brenner's method. There is a marked directional tendency during the growth process; the findings are compared with results of investigation on copper.

20448 OBSERVATIONS ON GROWTH SHAPE, PLASTIC DEFORMATION AND SLIP LINE OF SODIUM CHLORIDE WHISKER. K.Kamiyoshi and T.Yamakami.

Sci. Rep. Res. Insts. Tohoku Univ. A (Japan), Vol. 12, No. 3, 258-70 (June, 1960).

Observations were made on sodium chloride whiskers grown by the cellophane method used by Amelinckx. Three different growth shapes (needle, platelet and pyramid) were seen to grow on the cellophane surface. The crystal grew entirely at the base; tip growth or lateral thickening did not take place at all. The whisker exhibited large plastic deformation ($\Delta l/l_0$ = 50%-90%) before fracture occurred. The critical strain (plastic elongation at fracture) increased with decreasing cross-sectional area, but it decreased rapidly to zero when the cross-sectional area decreased less than $1 \times 10^{-3}mm^2$. The tensile strength, on the contrary, increased strongly with the decrease in cross-sectional area below $1 \times 10^{-3}mm^2$. Plastic deformation produced slip lines on the crystal surface. They were observed by optical and by electron microscopes. The slip usually occurred on a single set of (110) slip plane systems in a relatively large region of a whisker. In some cases, the transverse (90°) slip lines were wavy, and branching of the slip lines was seen. But in other cases, they were straight and parallel. The 45° slip lines could not be observed by the electron microscope. Cross slips were rarely observed. Etch pit observations revealed that the whisker contained many dislocations. Some interpretations of the results are attempted.

20449 NEEDLE-LIKE [WHISKER] GROWTH OF TITANIUM NITRIDE CRYSTALS. K.T.Wilke.

Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 7, 425-6 (1960). In German.

Reports the growth of whiskers of TiN on a tungsten wire heated to 1300°C in a gaseous mixture of $TiCl_4$, N_2, and H_2.

D.G.Holloway

20450 THE INFLUENCE OF THE DISTRIBUTION OF CATIONS IN MANY-COMPONENT STOICHIOMETRIC SPINEL ON THE EQUILIBRIUM PRESSURE OF OXYGEN.

A.N.Men'.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1101-4 (April, 1961). In Russian.

The dependence of the equilibrium pressure of oxygen on the composition of stoichiometric spinel was found by taking into account the distribution over sublattices. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 801-3 (Oct., 1961)].

K.G.Major

ATOMIC RADII, ELECTRONEGATIVITIES AND ACTIVATION ENERGIES OF COMPOUND INORGANIC SEMICONDUCTORS. See Abstr. 17675

ION-BOMBARDMENT EJECTION OF ATOMS FROM MONOCRYSTALS ALONG CRYSTAL AXES. See Abstr. 17590

CRYSTAL LATTICE STRUCTURES

20451 NEUTRON DIFFRACTION STUDIES IN SOLID STATE PHYSICS. K.Blinowski.

Nukleonika (Poland), Vol. 5, No. 7-8, 481-93 (1960).

Presents methods and results of slow-neutron spectrum measurements, cold neutron production, structural investigation of PbO, WC and FeS_2 (magnetic structure), and study of parasitic Bragg reflections observed in the neutron spectrum from crystal monochromators.

20452 ANISOTROPIC STRUCTURE FACTOR CALCULATIONS. D.R.Fitzwater.

Acta cryst. (Internat.), Vol. 14, Pt 12, 1242-4 (Dec. 10, 1961).

A general form of the anisotropic structure factor which is suitable for evaluation in any space group is presented. A simple scheme for specifying the space group symmetry avoids the use of special "patches". The suggested form in the case of general and most special positions reduces to a form which permits substantial savings in the time required to form the function arguments and is well adapted to computation of structure factors and derivatives on high speed digital computers.

20453 SOME THEORETICAL PROPERTIES OF THE DOUBLE-CRYSTAL SPECTROMETER USED IN NEUTRON DIFFRACTION. B.T.M.Willis.

Acta cryst. (Internat.), Vol. 13, Pt 10, 763-7 (Oct., 1960).

A treatment is given of the angular dependence of certain intensity functions which are important in spectrometer design. It provides a basis for the choice of various parameters, including, in particular, the Bragg angle of the crystal monochromator.

20454 A QUICKLY ADJUSTABLE VERTICAL GUINIER CAMERA. H.F.Fischmeister.

Acta cryst. (Internat.), Vol. 14, Pt 2, 113-15 (Feb., 1961).

A Guinier camera for use with a vertical X-ray tube is described which can be readjusted quickly and easily for radiations of different wavelength. All critical distances and angles are defined by exchangeable spacers that are adjusted once for all. Experience over a period of three years has shown that this method of positioning is sufficiently accurate to make visual or photographic final adjustments after each change of wavelength unnecessary.

20455 A VERTICAL WEISSENBERG CAMERA FOR HIGH AND LOW TEMPERATURES.

J.L.Amoros, M.Guibert, M.L.Canut and F.Arrese.

Rev. Cienc. apl. (Spain), Vol. 4, No. 81, 289-97 (July-Aug., 1961). In Spanish.

The construction is fully described. The high-temperature attachment is like that in Abstr. 3367 of 1956; temperatures down to -190°C can be obtained by liquid-nitrogen cooling. A.R.Stokes

20456 HUMIDITY CONTROL DEVICE FOR THE BUERGER PRECESSION CAMERA. J.R.Einstein.

J. sci. Instrum. (GB), Vol. 38, No. 11, 449-51 (Nov., 1961).

A device was designed and built to maintain a crystal in equilibrium with an atmosphere of constant relative humidity during X-ray photography with the Buerger precession camera. The device employs a small constant-temperature enclosure, mounted directly on the goniometer head of the camera. A resistance-wire winding is used to supply a small amount of heat to the enclosure. The temperature is maintained constant by a thermistor-controlled electronic circuit. Temperature control is not interrupted during adjustments to the goniometer head nor when the film is changed.

20457 SAFE UNIVERSAL MOUNTING AND ALIGNMENT SYSTEM FOR X-RAY GONIOMETERS.

W.Hughes and C.A.Taylor.

J. sci. Instrum. (GB), Vol. 38, No. 12, 493-5 (Dec., 1961).

A universal system by which all the goniometers in a particular X-ray laboratory may be positioned rapidly and simply on any X-ray generator is described. An integral part of the system is a "dummy" X-ray tube, an optical system producing a beam of light which permits the alignment of a goniometer to be carried out in complete safety from radiation. On transferring the goniometer to the X-ray generator no further adjustment is necessary. The system improves the efficiency of a laboratory in which many workers use the same goniometers and generators. It also improves the safety from radiation, particularly for teaching laboratories in which alignment of goniometers has to be carried out by relatively inexperienced personnel.

20458 AN AUTOMATIC RECORDING MICRODENSITOMETER DESIGNED FOR X-RAY CRYSTALLOGRAPHY.

V.A.Vuster [W.A.Wooster].

Kristallografiya (USSR), Vol. 5, No. 5, 788-94 (Sept.-Oct., 1960). In Russian.

All crystallographic X-ray photographs normally in use can be measured on the double-beam microdensitometer which is described. It can be used either to record automatically the optical density along straight or circular lines on the film, or to measure the integrated intensities of reflections on single crystal or prefer orientation photographs. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 749-55 (March-April, 1961)].

I.D.Brow

20459 HIGH TEMPERATURE HORIZONTAL DIFFRACTOMETER ATTACHMENT. J.Intrater.

Rev. sci. Instrum. (USA), Vol. 32, No. 8, 982 (Aug., 1961).

Describes an attachment which may be used with any horizonta X-ray diffractometer, and which provides for complete angular scanning ($2\theta = 0$-180°) at temperatures up to 1500°C. Accurate and convenient alignment of the specimen is possible by controls outsid of the specimen chamber. A sighting window permits temperature measurement of the specimen by optical pyrometer, or thermocouples can be used. J.Iba

DEVICE FOR ORIENTING AND MARKING FERROMAGNETIC MONOCRYSTAL SPHERES. See Abstr. 20111

20460 HISTOGRAPH. AN ENTIRELY AUTOMATIC SYSTEM FOR STEP COUNTING FOR AN X-RAY SPECTROMETER CONSTRUCTED FROM STANDARD COMPONENTS.

P.Bergé and M.Tournarie.

J. Phys. Radium (France), Vol. 21, Suppl. No. 11, 181 A-186 A (Nov., 1960). In French.

The apparatus described here permits the study step by step of a scattered beam of particles in terms of the scattering angle. It permits counting at a predetermined number of counts or at a fixed or variable time, the "time" being given either by a time base, or by a monitoring unit. The scattering angles are also recorded.

20461 A METHOD OF THE INTENSITY DISTRIBUTION MEASUREMENT OF THE SMALL-ANGLE SCATTERING OF X-RAYS ELIMINATING THE INFLUENCE OF THE IMPERFECT COLLIMATION. V.Syneček.

Acta cryst. (Internat.), Vol. 13, Pt 5, 378-80 (May, 1960).

A new method is described for the intensity distribution measurement of the diffuse radially symmetrical small-angle scattering pattern distorted by the finite height of the direct beam of negligibl width. This method consists in measuring the values of the intensities integrated along the lines parallel to the trace of the direct beam in the plane of observation. The true radial intensity distribution (corresponding to the use of the direct beam of point-like cross-section) derived from the distribution of these integrated intensities is unaffected both by the intensity distribution along the height of the direct beam and by the finite height of the exploring sl of the detector used for the intensity measurements.

20462 THE REQUIRED PRECISION OF INTENSITY MEASURE MENTS FOR SINGLE-CRYSTAL ANALYSIS.

D.W.J.Cruickshank.

Acta cryst. (Internat.), Vol. 13, Pt 10, 774-7 (Oct., 1960).

A discussion is given of the requirements necessary for determining bond lengths crystallographically within a limit of error of 0.01 A. A simple approximate formula is given relating the residu R to the coordinate estimated standard deviation.

20463 PRECISION LATTICE CONSTANT DETERMINATION. W.L.Bond.

Acta cryst. (Internat.), Vol. 13, Pt 10, 814-18 (Oct., 1960).

A single-crystal method of lattice constant determination is presented in which the several errors are minimized or correction computed. The apparatus measures the angle between two reflecting positions of the crystal. With nearly perfect crystals the lattic constants can be measured to a few parts in a million.

20464 A SYSTEMATIC USE OF Cu Kα AND Cu Kβ FOR COLLECTING INTENSITY DATA.

T.Watanabé and I.Taguchi.

Acta cryst. (Internat.), Vol. 14, Pt 1, 67-8 (Jan., 1961).

20465 A DIRECT GRAPHICAL METHOD FOR THE PRECISE DETERMINATION OF LATTICE PARAMETERS OF TETRAGONAL OR HEXAGONAL CRYSTALS.

E.J.Myers and F.C.Davies.

Acta cryst. (Internat.), Vol. 14, Pt 2, 194-7 (Feb., 1961).

A direct graphical method for the precise determination of lattice parameters of tetragonal or hexagonal crystals is described The method is applied to a binary equiatomic Ti—Al alloy and the results presented.

0466 METHOD OF DETERMINING THE SPECIMEN-SURFACE DISPLACEMENT OF AN X-RAY DIFFRACTOMETER.

.Delf.

. J. appl. Phys., Vol. 12, No. 8, 421-3 (Aug., 1961).

A simple method of determining the specimen-surface dis- ement of an X-ray diffractometer is described. The position of specimen surface is compared with the position of a glass slide nown specimen-surface displacement by means of a travelling roscope. The displacement of a specimen is found to 0.006 mm ch corresponds to a maximum angular error of 0.004° in 2θ for Philips diffractometer used, radius 17 cm. The displacement is wn to be critically dependent on the method of locking the speci- holder. This is overcome by performing the various steps of locking procedure in a certain fixed order. The effect of move- t of the specimen holder shaft on the displacement is discussed.

20467 ON THE SETTING OF CRYSTALS FOR X-RAY DIFFRACTION WORK.

araycochea and H.Cid-Dresdner.

a cryst. (Internat.), Vol. 14, Pt 2, 200-1 (Feb., 1961).

20468 RADIOCRYSTALLOGRAPHY OF STRONGLY RADIO-ACTIVE MATERIALS. J.Bloch.

ll. Soc. Franc. Mineral. Crist., Vol. 84, No. 3, 281-6 ly-Sept., 1961). In French.

Reviews methods for obtaining X-ray data from strongly dioactive samples. Describes a Bragg—Brentano spectrometer h monochromatization of the diffracted beam. Gives results on U—Mo system at 0.5% burn-up (~ 10 Curie sample), and on the nealing of the lattice expansion of UC at about 10^{-3}% burn-up.

R.S.Pease

20469 DIFFRACTOMETER METHODS IN THE PRECISION MEASUREMENT OF UNIT CELL PARAMETERS.

S.Zevin, M.M.Umanskii, D.M.Kheiker and Yu.M.Panchenko.

istallografiya (USSR), Vol. 6, No. 3, 348-56 (May-June, 1961). Russian.

The technique of these methods is examined. The methods of roducing corrections for dispersion, Lorentz factor and polari- tion factor, methods of truncating the diffraction peaks for ducing the measured region, and methods of measuring the unting rate are analysed and compared. [English translation in: viet Physics—Crystallography (USA), Vol. 6, No. 3, 277-83 ov.-Dec., 1961)].

20470 ON RESOLUTION AND LUMINOSITY OF A NEUTRON DIFFRACTION SPECTROMETER FOR SINGLE RYSTAL ANALYSIS. G.Caglioti, A.Paoletti and F.P.Ricci.

uclear Instrum. and Methods (Internat.), Vol. 9, No. 2, 195-8 ov., 1960).

Some criteria for the choice of the collimators for a crystal pectrometer for neutron diffraction are established in order to chieve a good compromise between luminosity and resolution. eneral expressions for the full width at half maximum and for the uminosity of the diffraction peaks are developed for single crystal amples.

20471 USE OF A TWO-CIRCLE DEVICE TO OBTAIN THREE-DIMENSIONAL NEUTRON DIFFRACTION ATA. B.T.M.Willis.

cta cryst. (Internat.), Vol. 14, Pt 1, 90-1 (Jan., 1961).

20472 SLIT HEIGHT CORRECTIONS IN SMALL ANGLE X-RAY SCATTERING. P.W.Schmidt and R.Hight, Jr.

cta cryst. (Internat.), Vol. 13, Pt 6, 480-3 (June, 1960).

A method of correcting experimental small angle X-ray scatter- ng curves for the effects of the height of the collimating slits is eveloped. The method has the advantage of eliminating the need for umerical differentiation of the experimental curve. An expression uitable for numerical calculation is given, and an analysis is made f the error in the numerical approximation. The results of some pplications of these slit correction techniques are discussed.

20473 INTERPRETATION OF DIFFRACTOMETER LINE PROFILES DISTORTION DUE TO THE DIFFRACTION PROCESS. J.Ladell.

Acta cryst. (Internat.), Vol. 14, Pt 1, 47-53 (Jan. 10, 1961).

On the basis of the kinematic theory of powder diffraction it is shown that the angle factor

$$J(\theta) \propto \sin^2\theta \cos\theta/(1 + \cos^2 2\theta)$$

describes the distortion of the line profile due to the diffraction process when the incident radiation consists of a spectral distribution $h_1(\lambda)$ (the angle scale equivalent of which is $h(\epsilon)$). The distortion includes the effects of the Lorentz and polarization factors, trigonometric factors associated with the experimental powder method and the effects of physical absorption. In the absence of other aberrations the angle scale spectral distribution $h(\epsilon)$ is (to the first order) recovered from the observed distribution $f(\epsilon)$ from the equation $f(\epsilon)J(\theta) = h(\epsilon)$. The value of Δ_{LPU}, the correction to be applied to counterbalance the shift in the observed profile due to the distortion of the profile caused by the diffraction process, is inferred from $J(\theta)$ and is applicable to crystal powders encountered in precision lattice parameter determinations.

20474 THE LORENTZ FACTOR IN POWDER DIFFRACTION. E.R.Pike.

Acta cryst. (Internat.), Vol. 14, Pt. 1, 53-4 (Jan. 10, 1961).

20475 ABSORPTION CORRECTIONS FOR DIFFRACTION MEASUREMENTS FROM LARGE SINGLE CRYSTALS.

A.Hargreaves and R.A.L.Sullivan.

Acta cryst. (Internat.), Vol. 14, Pt 2, 150-2 (Feb., 1961).

General expressions are derived for the absorption corrections required in evaluating the intensities of beams diffracted from large crystal blocks.

20476 X-RAY ABSORPTION FACTORS FOR ELLIPSOIDAL CRYSTALS. D.R.Fitzwater.

Acta cryst. (Internat.), Vol. 14, Pt 5, 521-6 (May 10, 1961).

The absorption factor integral for a general ellipsoidal crystal was transformed to spherical polar coordinates. The resulting exponential in the integral was expanded in a power series and the triple integration was carried out term by term. The process was stopped after the fifth order term but could be carried further. Four integrals could not be directly integrated and were evaluated by series expansions and integrations. The resulting series were tabulated as a function of one parameter. The termination of the absorption factor series with the fifth-order term gives results for a sphere with <2 % error for $\mu R = 1{\cdot}0$.

20477 METHOD OF MEASURING THE DIFFUSE-SCATTERING INTENSITIES OF POLYCRYSTALS.

V.I.Iveronova and A.A.Katsnel'son.

Kristallografiya (USSR), Vol. 5, No. 5, 795-7 (Sept.-Oct., 1960). In Russian.

The contribution to diffuse X-ray scattering from short-range order is often obscured by fluorescence, higher-order wavelengths, and white radiation as well as by scattering from air and from the bonding materials used in preparing the polycrystalline specimens. Methods are suggested for removing these extraneous effects and are tested by measurements on Ni and Ni_3Pt. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 756-8 (March-April, 1961)].

I.D.Brown

20478 APPLICABILITY OF CORRECTION FORMULAE FOR PRIMARY AND SECONDARY EXTINCTION.

O.N.Shivrin.

Kristallografiya (USSR), Vol. 5, No. 5, 797-800 (Sept.-Oct., 1960). In Russian.

The assumptions implicit in various formulae used to describe primary and secondary X-ray extinction in crystals are compared in an attempt to decide which formulae are the best to use. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 758-61 (March-April, 1961)].

I.D.Brown

20479 INFLUENCE OF SOME FACTORS OF EXPOSURE SYMMETRY ON THE MAGNITUDE OF THE RANDOM ERROR IN THE PRECISION DETERMINATION OF LATTICE PERIOD. Ya.M.Golovchiner.

Kristallografiya (USSR), Vol. 6, No. 3, 357-62 (May-June, 1961). In Russian.

The part played by exposure geometry in the determination of the optimum object—film distance for precision determinations of lattice period is examined. When sharp-focus tubes are used, this distance is of the order of 80 mm, in agreement with the results of Pines et al. (Abstr. 9013 of 1959). When an ordinary tube is used, the object—film distance is advantageously increased to 200-350 mm. Distances of the order of 1000 mm or more are unsuitable. [English translation in: Soviet Physics—Crystallography (USA), Vol. 6, No. 3, 284-7 (Nov.-Dec., 1961)].

20480 A NOTE ON PEAK DISPLACEMENTS IN X-RAY DIFFRACTOMETRY. A.J.C.Wilson.

Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 249-55 (Aug., 1961).

It is shown that at moderately high Bragg angles the shifts $\Delta(2\theta)$ of the peaks of X-ray diffraction maxima resulting from geometrical aberrations of the apparatus are to a first approximation the same as those of the centroids. A second approximation to $\Delta(2\theta)$ is obtained by adding $Vh'''/2h''$ to the centroid shift, where V is the variance of the aberration and h'' and h''' are the second and third derivatives of the observed line profile at its maximum. Forms of the correction suitable for practical application are discussed. The peak shifts resulting from dispersion and the Lorentz factor cancel to a first approximation. Physical aberrations, such as absorption, that multiply the line profile $I(\lambda)d\lambda$ by a factor $f(\lambda)$ depending on wavelength, shift the peak by approximately $\Delta(2\theta) = -2f'I\tan\theta/\lambda f I''$, where f, f', I, I'' are the values of the functions and their derivatives at the peak.

20481 CORRECTION OF THE SAMPLE-HOLDER ERROR IN NEUTRON DIFFRACTION. F.Boutron and P.Mériel.

Bull. Soc. Franc. Mineral. Crist., Vol. 83, No. 4-6, 125-7 (April-June, 1960). In French.

It is shown theoretically that the presence of the cylindrical sample holder (for example when using powdered specimens) in neutron diffraction has an effect on the intensity of the diffracted beam. An expression is derived for a correction factor (B). B is a function of μ (linear coefficient of absorption), R (the radius of the tube) and θ (angle of diffraction). A table is given of B for different values of μR and θ. Experimental tests showed that the corrections calculated theoretically are valid. J.Iball

20482 AN ASSESSMENT OF THE POWER OF THE NON-NEGATIVITY CRITERION AS USED IN X-RAY CRYSTAL STRUCTURE DETERMINATIONS. T.Löfgren.

Acts cryst. (Internat.), Vol. 13, Pt 5, 429-33 (May, 1960).

It is shown why the requirement of reality coupled with that of non-negativity and certain symmetry of the electron-density function constitutes a weak criterion in space groups lacking translational symmetry elements, at least in so far as the requirements mentioned are exploited by any Harker—Kasper inequalities. In space groups with translational symmetry operations the situations is fundamentally different.

20483 ON THE THEORY OF ORDER—DISORDER (OD) STRUCTURES.

K.Dornberger-Schiff and H.Grell-Niemann.

Acta cryst. (Internat.), Vol. 14, Pt 2, 167-77 (Feb., 1961).

OD-structures consisting of equivalent layers are first characterized as having pairs of adjacent layers which are all equivalent. Then a slightly more general condition—the "vicinity condition" — is formulated which is satisfied not only by all ordered structures but also by all OD-structures. Partial operations (POs) are seen to be of fundamental importance for characterizing the symmetry properties of OD-structures and the set of POs of a certain structure is called an OD-groupoid. OD-structures of the same substance, built of the same kind of layers with the same kinds of pairs of adjacent layers are said to belong to the same family, the corresponding OD-groupoids to the same OD-groupoid family. Twins of one particular type are described as special members of families of OD-structures. A report on the deduction of a complete list of OD-groupoid families is given, and the resulting numbers of such families with different symmetry characteristics are listed in tables. There are 333 in all.

20484 THE EXTINCTION RULE FOR REFLEXIONS IN SYMMETRICAL ELECTRON-DIFFRACTION SPOT PATTERNS.

J.M.Cowley, A.F.Moodie, S.Miyake, S.Takagi and F.Fujimoto.

Acta cryst. (Internat.), Vol. 14, Pt 1, 87-8 (Jan., 1961).

20485 CENTRAL SCATTERING OF X-RAYS BY FILIFORM PARTICLES. V.Luzzati and H.Benoit.

Acta cryst. (Internat.), Vol. 14, Pt 3, 297-300 (March 10, 1961). In French.

The asymptotic form of the intensity scattered by an assembly of filiform particles is determined for large values of s and the geometrical parameters it depends on are given. The influence of certain types of configuration on this asymptotic behaviour is discussed.

20486 AN EXPERIMENTAL STUDY, BY TRANSMISSION, OF THE INTEGRATED ABSOLUTE REFLECTIONS OF X-RAYS. A.Authier.

Acta cryst. (Internat.), Vol. 14, Pt 3, 287-91 (March 10, 1961). In French.

An experimental study of the integrated intensities and the rocking curves for beams having undergone the anomalous transmission of X-rays was carried out for several thicknesses o the sample using a double-crystal spectrograph. Absolute measurements were made with an ionization chamber on nearly perfect silicon crystals. The results are in good agreement with those of the dynamical theory.

20487 A THEORETICAL STUDY OF PENDELLÖSUNG FRINGES. I. GENERAL CONSIDERATIONS. N.Kato.

Acta cryst. (Internat.), Vol. 14, Pt. 5, 526-32 (May, 1961).

The assumption of an incident plane wave is shown to be not adequate for single-crystal experiments of X-ray diffraction (Laue case). A dynamical theory of diffraction is formulated for a gener type of monochromatic incident wave. Fundamental aspects of wav behaviour are discussed in terms of wave-bundle considerations. Diffraction phenomena are classified by $\Delta\theta$ (an angular width of single-crystal reflection) and Ω_0 (a width in which the angular spectrum of an incident coherent wave takes an appreciable value). If $\Delta\theta > \Omega_0$, a plane-wave assumption is adequate. This is usually the case for electron diffraction. If $\Delta\theta \lesssim \Omega_0$, a spherical wave assumption is more appropriate and most of X-ray cases fall unde this alternative. Furthermore, a criterion is given to distinguish between Fresnel and Fraunhofer diffraction in a crystalline mediu "Pendellösung" fringes of X-rays (Abstr. 13902 of 1959) can be interpreted as Fraunhofer diffraction, while those of electrons are observed in a Fresnel diffraction region. The essential features o section patterns, particularly "hook-shaped" fringes, can now be explained.

20488 A THEORETICAL STUDY OF PENDELLÖSUNG FRINGES. II. DETAILED DISCUSSION BASED UPON A SPHERICAL WAVE THEORY. N.Kato.

Acta cryst. (Internat.), Vol. 14, Pt 6, 621-36 (June, 1961).

Based upon the general formulation of Pt I, explicit expressio for the crystal wave fields and the vacuum wave fields are obtaine assuming a spherical wave as the incident beam. For thick parts of crystals, absorption effects are taken into account. The same results as expected from the energy-flow theory (Kato, 1960) are obtained as a special case. "Pendellösung" phenomena of X-rays are discussed. In particular, "hook-shaped" patterns (Abstr. 1390 of 1959) can be fully explained. Values of integrated intensity according to the ordinary theory do not need to be revised.

20489 DIRECT DETERMINATION OF X-RAY REFLECTION PHASE RELATIONSHIPS THROUGH SIMULTANEOUS REFLECTION. M.Hart and A.R.Lang.

Phys. Rev. Letters (USA), Vol. 7, No. 4, 120-1 (Aug. 15, 1961).

Use is made of the displacement of "pendellösung" fringes around the region of simultaneous reflection by two orders (see Abstr. 13902 of 1959, and two preceding abstracts). The method gave the correct relation between the phases of three orders for germanium. A.R.Stoke

20490 THE SEPARATION OF SHORT RANGE ORDER AND SIZE EFFECT DIFFUSE SCATTERING. B.Borie.

Acta cryst. (Internat.), Vol. 14, Pt 5, 472-4 (May 10, 1961).

Short-range-order diffuse scattering in binary substitutional solid solutions is often obscured by modulations associated with th fact that the two kinds of atoms are of different sizes. A method is described for the separation of these two components of the diffuse scattering, and it is illustrated by its application to CuAu. It is suggested that a determination of the size effect coefficients along with the short-range-order parameters will provide a greater insight into the short-range structure of an alloy.

20491 MATRIX THEORETICAL DERIVATION OF INEQUALITIES. II. T.Oda, S.Naya and I.Taguchi.

Acta cryst. (Internat.), Vol. 14, Pt 5, 456-8 (May 10, 1961).

For Pt I see Abstr. 7627 of 1959. The present paper shows vay starting from a matrix-theoretical representation of urier series and leading to the reduction by the symmetry operties of the matrix of Karle and Hauptman (Abstr. 6170 of 50) type, so that a general form of fundamental inequalities involving structure factors can be derived for any given space group.

20492 THE THEORY OF X-RAY SCATTERING IN ORDERING ALLOYS WITH A DISTORTED CRYSTAL LATTICE.

A.Smirnov and E.A.Tikhonova.
z. tverdogo Tela (USSR), Vol. 3, No. 4, 1238-48 (April, 1961).
Russian.

The intensity of true reflections and of diffuse scattering of rays is determined theoretically in terms of the long-range der parameters and alloy composition, allowing for distortion the crystal lattice caused by different atomic sizes. The attering by β-brass is considered as an example. [English anslation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 9-905 (Oct., 1961)]. R.F.S.Hearmon

20493 ON THE INTERFERENCE PHENOMENA OF COMPTON SCATTERING FROM DIAMOND. Y.Yoneda.

Phys. Soc. Japan, Vol. 16, No. 8, 1570-4 (Aug., 1961).

An explanation is given of the divergent beam pattern due to ompton scattering. The pattern is not caused by a point source X-rays outside the crystal but by interference of X-rays produced iformly in a small crystal. It is shown experimentally that the terference lines can appear even for a small crystal if a microeam is used.

20494 ANALYSIS OF THE X-RAY DIFFRACTION PATTERN OF HELICAL STRUCTURES. G.N.Ramachandran.

roc. Indian Acad. Sci. A, Vol. 52, No. 5, 240-54 (Nov., 1960).

The paper deals with the theory of the diffraction pattern of elical structures whose number of units per turn (n) is neither ntegral nor rational. The conventional treatment has the defect at the repeat spacing along the helix axis is taken as the standard f reference, and this does not exist, being infinite, when n is rrational. This difficulty is got over by considering the "unit eight" (h = resolved component of a unit along the axis) and "unit wist" (t = fraction of a complete rotation for one unit, = 1/n), which ary continuously irrespective of n being rational or irrational. xplicit formulae are obtained in terms of their Bessel indices for he observed layer line-spacings, which turn out to be very simply elated to the reciprocals of unit height and pitch. A technique for nalysing the observed diffraction pattern for the elements of the elical structure is also given, with examples. The coiled-coil case s seen to have the same general features as that of the simple coil, he layer line-spacing being now related to two pitches, those of the ajor and the minor helices, and to the unit height. The relationship between the diffraction pattern of a helix in its uncoiled and its oiled-coil form is found to be similar to the multiplet splitting produced by a magnetic field in spectral lines.

20495 SOME REGULARITIES IN THE ELASTIC SCATTERING OF MEDIUM-ENERGY ELECTRONS. A.N.Pilyankevich.

Kristallografiya (USSR), Vol. 6, No. 3, 341-7 (May-June, 1961).
In Russian.

Using approximate Slater wave-functions, a study is made of the dependence of certain characteristics in the elastic scattering of medium-energy electrons on the atomic number of the scattering atom. Periodicity is established in the change in these characteristics. [English translation in: Soviet Physics—Crystallography (USA), Vol. 6, No. 3, 272-6 (Nov.-Dec., 1961)].

20496 "ANOMALOUS DISPERSION" EFFECTS IN ELECTRON DIFFRACTION AND THEIR POSSIBLE APPLICATIONS.

R.Parthasarathy.
Acta cryst. (Internat.), Vol. 14, Pt 6, 690-1 (June, 1961).

In certain cases the phases of the Fourier waves of a non-centric crystal containing only one type of atom can be determined. For this to be possible, Friedel's law must be violated; this happens if, in the dynamical theory, the effect of weak waves is considered: then the phase can be determined from the difference in intensity of inverse reflections. M.A.Taylor

20497 NEUTRON DIFFRACTION BY HELICAL SPIN [MAGNETIC] STRUCTURES. W.C.Koehler.

Acta cryst. (Internat.), Vol. 14, Pt 5, 535-6 (May 10, 1961).

20498 PARASITIC MULTIPLE BRAGG SCATTERING IN THE NEUTRON CRYSTAL SPECTROMETER.

D.A.O'Connor and J.Sosnowski.
Acta cryst. (Internat.), Vol. 14, Pt 3, 292-7 (March 10, 1961).

Nuclear-reactor slow-neutron spectra obtained by the use of a crystal monochromator contain a number of irregular fluctuations in the form of inverted peaks, due to fluctuations in the reflectivity of the crystal. It is shown that these fluctuations are due to Bragg reflection of neutrons by reflecting planes other than that used to obtain the monochromatic beam. Approximate formulae are derived for the magnitude and half-width of these inverted peaks for a mosaic crystal. Experiments carried out with copper and aluminium single crystals confirm that the Bragg angles at which the peaks occur depend on the type of crystal structure and not on the lattice constants. The measured depth of the better defined peaks is in satisfactory agreement with that calculated on the basis of the approximate formulae. Comparison of measurements with the crystals at room temperature and liquid-air temperature failed to reveal the presence of inelastic scattering as a contributory factor to the fluctuations in reflectivity.

20499 A SIMPLIFIED FORMULA FOR THE CALCULATION OF THE X-RAY INTENSITY DIFFRACTED BY A MONODIMENSIONALLY DISORDERED STRUCTURE. G.Allegra.

Acta cryst. (Internat.), Vol. 14, Pt 5, 535 (May 10, 1961).

20501 THEORY OF INELASTIC SCATTERING OF NEUTRONS BY IMPERFECT CRYSTALS. M.A.Krivoglaz.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 567-84 (Feb., 1961).
In Russian.

Inelastic one-phonon scattering of neutrons by solid solutions or by crystals containing defects is considered. Phonon scattering by static inhomogeneities in a crystal results in broadening of the peaks in the energy distribution of coherently scattered neutrons. This broadening depends strongly on the degree of order in the arrangement of the atoms of the solution and becomes anomalously large near critical points on the decomposition curve and near points of second-order phase transitions. The peculiarities are investigated of the broadening in the scattering by vibrations corresponding to extrema of the vibration spectrum. It is shown that including the effects of defects and correlations in the solution results in the appearance of an angular dependence of the intensity of incoherent scattering, and that imperfection of the crystal leads to a smearing out of singularities in the energy spectrum of this scattering and in the distribution function of the vibration frequencies. The incoherent scattering increases sharply near critical points on the decomposition curve. The scattering of neutrons by local vibrations is dealt with. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 397-409 (Aug., 1961)].

20500 TEMPERATURE DIFFUSE SCATTERING FOR CUBIC POWDER PATTERNS. B.Borie.

Acta cryst. (Internat.), Vol. 14, Pt 6, 566-8 (June, 1961).

General expressions for the various orders of temperature diffuse scattering (TDS) for cubic elements are developed which show that the diffuse peaks at the Bragg maxima are broader for the higher-order TDS contributions, and which also show that the average value of l-th order TDS (in electron units per atom) is $f^2 \exp[-2M](2M)^l/l!$. The relevance of this result to the Warren theory (1953) and the more recent Paskin (1958, 1959) theory for TDS for cubic powders is discussed, and it is shown that the Warren theory is more accurate.

20502 THE THEORY OF INELASTIC SCATTERING OF NEUTRONS BY IMPURITY CENTRES IN CRYSTALS.

V.N.Kashcheev and M.A.Krivoglaz.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3167-80 (Oct., 1961).
In Russian.

Expressions are derived for the differential nuclear and magnetic inelastic scattering cross-sections for the scattering of neutrons by impurity centres, in processes in which there are electron transitions in the centres. Non-magnetic inelastic scattering is possible when there is a phonon—electron interaction. The calculation is carried out for a weak interaction approximation and for an adiabatic approximation for the cases of large and small phonon production accompanying the electron transition. The energy distribution of the scattered neutrons is calculated and the parameters of the theory are discussed for the case of impurity centres in ionic crystals. It is suggested that inelastic scattering of this type should be observed experimentally. [English translation in: Soviet Physics—Solid State (USA)]. D.A.O'Connor

20503 INTERFERENCE DIVISION EFFECTS ON TRANSMISSION THROUGH MACROSCOPIC CRYSTAL WEDGES.

G.Lehmpfuhl and K.Molière.

Z. Phys. (Germany), Vol. 164, No. 4, 389-408 (1961). In German.

Describes experiments on the transmission of electron beams through right-angle wedges of MgO crystals. A double-refraction effect is obtained in accordance with the dynamical theory of diffraction, and structure factors of strong reflections can be derived from this effect. A.R.Stokes

20504 ANOMALOUS VARIATIONS IN THE LATTICE CONSTANTS AND THE DIELECTRIC AND PIEZOELECTRIC PARAMETERS OF $(Ba, Pb)TiO_3$ SOLID SOLUTIONS.

Yu.N.Venevtsev, V.S.Bondarenko, G.S.Zhdanov, V.V.Chkalova and N.G.Stember.

Kristallografiya (USSR), Vol. 6, No. 3, 375-80 (May-June, 1961). In Russian.

A study was made of solid solutions ($PbTiO_3$ content up to 20 wt %) which were prepared from high-purity materials. Previous results from materials of technical grade are confirmed; the lattice constants, dielectric constant, piezoelectric constants, and other parameters show anomalous effects as the composition is varied. The nature of the anomalies is discussed. [English translation in: Soviet Physics—Crystallography (USA), Vol. 6, No. 3, 298-301 (Nov.-Dec., 1961)].

X-RAY INVESTIGATION OF STACKING FAULTS IN DEFORMED TANTALUM. See Abstr. 17547

20505 CORRECTION AND INTERPRETATION OF FOURIER COEFFICIENTS OF X-RAY DIFFRACTION PATTERNS FROM VERY SMALL, DISTORTED CRYSTALS.

D.H.Kobe.

Acta cryst. (Internat.), Vol. 13, Pt 10, 767-9 (Oct., 1960).

Presents a method for correcting the Fourier coefficients of $(00l)$ X-ray diffraction patterns from powders of very small, distorted crystals to take into consideration a function of the diffraction angle that should multiply the Fourier series. The function, which is usually assumed constant, is the product of the crystal structure factor, the polarization factor, and the Lorentz factor, and can vary greatly over the diffraction peak in some cases. The corrected coefficients must then be separated into the particle size coefficients and the distortion coefficients. A method for obtaining the discrete particle size distribution function directly from the particle size coefficients is presented, The distortion coefficients are used to determine the moments of the distortion, from which the probability density functions for the distortion can be obtained by means of a Gram—Charlier series.

20506 ON THE TREATMENT OF ILL-CONDITIONING.

J.Donohue and E.Heilbronner.

Acta cryst. (Internat.), Vol. 14, Pt 1, 83 (Jan., 1961).

It is suggested that the least-squares method of fitting a plane to a set of points (atoms) (Abstr. 13917 of 1959) can be improved by a transformation of the basic equations. A.R.Stokes

20507 A SIMPLE PRECISION METHOD FOR THE DETERMINATION OF CELL PARAMETERS.

T.Löfgren.

Acta cryst. (Internat.), Vol. 14, Pt 1, 85-6 (Jan. 10, 1961).

The angle of rotation of a crystal between Bragg-reflection positions is measured, rather than the angle between diffracted beam directions. A Weissenberg goniometer is used, and an example indicates an accuracy of about 1 part in 10^4. A.R.Stokes

20508 SIMPLIFIED CONSTRUCTION OF COMPLEX CRYSTAL MODELS.

D.L.Wood, C.R.Geith, C.Y.Pan Liang and A.G.Dockrill.

Acta cryst. (Internat.), Vol. 14, Pt 3, 310-12 (March 10, 1961).

A simple method of making crystal models is described. The atoms are represented by $\frac{1}{2}$ in. diameter coloured plastic spheres strung on nylon mono-filament in a transparent plastic box. The construction minimizes the effect of structural members on the visualization of atomic spatial relationships, making a more versatile model than any commercially available. Details of the layout are simple, and the assembly requires only moderate mechanical skill.

20509 ESTIMATION OF A CRYSTALLOGRAPHIC ORIENTATION RELATIONSHIP.

H.M.Otte.

Acta cryst. (Internat.), Vol. 14, Pt 4, 360-1 (April, 1961).

Two alternative procedures for obtaining the orientation relationship using the stereographic net and numerical methods are described. Their principal advantage over Mackenzie's method [Acta cryst. (Internat.), Vol. 10, Pt 1, 61 (Jan., 1959)] is th greatly increased speed achievable; the accuracy is commensurat with that of standard Laue photographs.

20510 SCALING FACTORS AND TEMPERATURE FACTORS.

J.Gaultier and C.Hauw.

Acta cryst. (Internat.), Vol. 14, Pt 4, 438-9 (April, 1961). In French.

A method of derivation from the intensity distribution within the Patterson peak at the origin is described. An application of th method is given. M.A.Tayl

20511 WEIGHTING FACTORS FOR SINGLE-CRYSTAL X-RA DIFFRACTION INTENSITY DATA.

H.T.Evans, Jr.

Acta cryst. (Internat.), Vol. 14, Pt 6, 689 (June, 1961).

The assignment of weighting factors to intensity data from fil and counter measurements is discussed. M.A.Taylo

20512 RELIABILITY OF UNIT CELLS DERIVED FROM POWDER DIFFRACTION PATTERNS.

P.M. de Wolff.

Acta cryst. (Internat.), Vol. 14, Pt 6, 579-82 (June, 1961).

It is shown that the reliability of a unit cell, obtained by indexing a powder pattern, depends on the ratio of the actual discrepancies to the average discepancies Δ which would result from an arbitrary unit cell of the same Bravais type and of about the same size. Expressions for Δ, for all non-cubic Bravais types of lattice, are derived from statistical considerations based on the number of calculated lines below a given Bragg angle.

20513 THEORETICAL PATTERSON DIAGRAMS IN TWO-DIMENSIONAL SPACE: CASE OF STRUCTURES CONTAINING TWO ATOMS PER ASYMMETRIC UNIT.

B.Rérat and C.Rérat.

Bull. Soc. Franc. Mineral. Crist., Vol. 83, No. 4-6, 134-40 (April-June, 1960). In French.

Patterson diagrams are reproduced for two independent atoms in each of the 17 plane-groups of symmetry. The experimental Patterson diagram of $(CH_3)_3NO.HCl$ is compared with the theoretica diagram for the plane-group pgg. A.R.Stoke

20514 A METHOD OF INTERPRETING PHOTOGRAPHS OF DIFFUSE SCATTERING FROM CRYSTALS OF THE HEXAGONAL SYSTEM.

Yu.A.Bagaryatskii.

Kristallografiya (USSR), Vol. 4, No. 6, 919-21 (Nov.-Dec., 1959). In Russian.

A method of determining the coordinates of a scattering point in reciprocal space from the coordinates of the point on an X-ray photograph is given for hexagonal single crystals. [English translation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 6, 875-7 (June, 1960)]. M.A.Taylo

20515 AN INSTRUMENT FOR WORKING UP THE X-RAY PATTERNS GIVEN BY POLYCRYSTALLINE TRICLINI SUBSTANCES.

S.L.Nudel'man.

Kristallografiya (USSR), Vol. 5, No. 5, 819-23 (Sept.-Oct., 1960). In Russian.

Previously (Abstr. 8568 of 1952; 13911 of 1959; 18365 of 1960) the author has described an instrument for indexing X-ray powder photographs. The present paper describes how it may be used to index powder patterns of triclinic crystals, taking $CuSO_4.5H_2O$ as an example. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 782-7 (March-April, 1961)]. I.D.Brow

20516 THE FOURIER INTEGRAL OF THE MINIMUM FUNCTION AND THE SIGNS OF STRUCTURAL AMPLITUDE

V.I.Simonov and B.M.Shchedrin.

Kristallografiya (USSR), Vol. 6, No. 3, 363-74 (May-June, 1961). In Russian.

The principles are advanced for setting up programmes to calculate the Buerger M(r)-functions and for finding the phase relatio ships with respect to the modified minimum function (Abstr. 7863 o 1961). The effectiveness of the proposed methods is tested on a two-dimensional hypothetical structure. [English translation in: Soviet Physics—Crystallography (USA), Vol. 6, No. 3, 288-97 (Nov.-Dec., 1961)].

20517 THREE-DIMENSIONAL OPTICAL TRANSFORMS.

G.Harburn and C.A.Taylor.

oc. Roy. Soc. A (GB), Vol. 264, No. 1318, 339-54 (1961).

In recent years optical diffraction patterns have been used to sist in the solution of certain X-ray diffraction problems. The ost useful technique — which is based partly on the properties of urier transforms and partly on optical experiments — is ually known as the optical-transform technique. It has, however, far been confined to problems involving the projection of crystal ructures on to a plane. The present work is aimed at extending e application to full three-dimensional structures. It is shown at this is most simply achieved by controlling the relative phases beams of light; a method of phase control using circularly larized light and half-wave plates of mica is described. The eory of the method, experimental details, and the demonstration of s validity are given. In order to gain experience in the use of ree-dimensional optical transforms for solving X-ray diffraction roblems a known structure was examined, and the results of this ork are included. Although this work was primarily concerned with plications to X-ray diffraction, it is thought that the method of ontinuous phase changing, which is simple and linear, may find ses in other fields.

20518 HARTREE—FOCK ATOMIC SCATTERING FACTORS FOR THE IRON TRANSITION SERIES.

.E.Watson and A.J.Freeman.

cta cryst. (Internat.), Vol. 14, Pt 1, 27-37 (Jan. 10, 1961).

Atomic scattering factors for thirty-five atoms and ions of the ron group transition series (Sc to Cu) were determined from Vatson's recently calculated Hartree—Fock wave-functions (Abstr. 737 of 1960) and compared with the few other available calculations. rincipal scattering factors were also computed, following the ethods of Freeman (1959), for the 3d electrons of those atoms ontaining nonspherical charge distributions. As shown by Weiss nd Freeman (Abstr. 12028 of 1960) these are all that are needed or determining (from the measured neutron form factor) the patial symmetry of the outer electrons in magnetic materials. rgon core scattering factors were also calculated, and, on the asis of these new results, the question of the constancy of the argon ore is discussed quantitatively. Analysis of the 3d transforms for ifferent stages of ionization shows another difficulty for the Weiss—eMarco experiments (Abstr. 7651 of 1959).

HARTREE—FOCK ATOMIC SCATTERING FACTORS FOR THE NEUTRAL ATOM IRON TRANSITION SERIES. See Abstr. 19606

ATOMIC SCATTERING FACTORS FROM WAVE FUNCTIONS CALCULATED BY THE POLY-DETOR METHOD: Cl, Cl^-, S AND S^-. See Abstr. 17285

X-RAY SCATTERING FACTORS OF TWO-ELECTRON IONS. See Abstr. 17286

ATOMIC SCATTERING FACTORS FOR THE TWO-ELECTRON IONS. See Abstr. 17287

20519 FERROMAGNETIC AND FERROELECTRIC SPACE GROUPS.

N.N.Neronova and N.V.Belov.

Kristallografiya (USSR), Vol. 4, No. 6, 807-12 (Nov.-Dec., 1959). In Russian.

The 3 Shubnikov point groups and the corresponding 275 space groups are given for ferroelectrics and ferromagnetics. The symbols are given in international form. [English translation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 6, 769-74 (June, 1960)]. M.A.Taylor

20520 LATTICE CONSTANTS OF HARD ALUMINIUM WIRES.

M.E.Straumanis and C.H.Cheng.

J. Inst. Metals (GB), Vol. 88, Pt 6, 287-8 (Feb., 1960).

Precision measurements of lattice constants of hard drawn pure Al wire, parallel and perpendicular to the wire axis, at temperatures from 10° to 60°C are reported and expansion coefficients are derived. H.Mykura

20521 STRUCTURAL STUDY OF BERYLLIUM BY ELECTRON MICROSCOPY AND ELECTRON DIFFRACTION OF THIN SECTIONS.

A.Saulnier.

J. nuclear Materials (Internat.), Vol. 2, No. 4, 299-309 (Dec., 1960). In French.

20522 THE STRUCTURE OF ELECTRODEPOSITED CHROMIUM.

M.Matsunaga.

Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, 177-83 (June, 1960).

The crystal orientation and the degree of specular gloss of electrodeposited chromium were studied for deposits obtained at current densities from 10 to 100 A dm^{-2} and temperatures from 20° to 70°C by using three kinds of chromic acid baths:

(a) CrO_3 250 gm l^{-1}, H_2SO_4 2.5 gm l^{-1}

(b) CrO_3 250 gm l^{-1}, H_2SO_4 1.0 gm l^{-1}, Na_2SiF_6 2.5 gm l^{-1}

(c) CrO_3 600 gm l^{-1}, H_2SO_4 3.8 gm l^{-1}, Sugar 10 gm l^{-1}.

The brightest deposits are characterized by (111) preferred orientation as has been shown by Yoshida (1943), and Hume-Rothery and Wyllie (1943). Diagrams are prepared showing the effect of temperature and current density on the degree of specular gloss and crystal orientation of the deposits. In addition to the well known (111) orientation, (110) and modified (111) orientations are formed at high temperature.

20523 SOME OBSERVATIONS OF COPPER DEPOSITS ON SINGLE CRYSTALS OF COPPER.

I.Giron and F.Ogburn.

J. Electrochem. Soc. (USA), Vol. 108, No. 9, 842-6 (Sept., 1961).

Isolated faces of copper single crystals were plated with copper from copper sulphate-sulphuric acid solutions. Deposits on {100} and {110} faces, despite the presence of grain boundaries, gave X-ray diffraction patterns showing uniform lattice orientation. The grain boundaries were associated with topographic features of the deposits. Over-all metal distribution showed a tendency to deviate from that of polycrystal deposits on polycrystalline bases

STABLE ATOMIC CONFIGURATIONS FOR AN INTERSTITIAL IN COPPER. See Abstr. 17504

20524 X-RAY DIFFRACTION SPIKES OF DIAMOND.

Y.Yoneda.

Nature (GB), Vol. 191, 1187-8 (Sept. 16, 1961).

Using the method of Frank (Abstr. 1759 of 1957), a recalculation is made of the theoretically expected intensities of the X-ray diffraction spikes of diamond based on the concept of segregated (100) planes of impurity atoms. A nitrogen concentration of 0.8% is computed. See also following abstract. S.Tolansky

20525 X-RAY DIFFRACTION SPIKES OF DIAMOND.

F.C.Frank.

Nature (GB), Vol. 191, 1187 (Sept. 16, 1961).

The calculations of Yoneda (preceding abstract) are commented on and the query raised as to whether these calculations are superior to the original calculations made by Frank. The basis of Yoneda's revision of earlier data is not considered to be apparent. It is emphasized that the diffraction evidence alone is incapable of discriminating between a variety of models, and it is considered that the matter cannot be settled until X-ray, infrared, absorption and spin resonance measurements are available for the same diamond sample. S.Tolansky

20526 THE ELECTRONIC DISTRIBUTION IN DIAMOND AND THE INTENSITIES OF X-RAY REFLECTIONS.

H.C.Bolton and J.W.Heaton.

Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 239-48 (Aug., 1961).

A theoretical calculation of the electronic charge distribution in the diamond lattice is presented. The method used is that of Thomas and Fermi and two angular terms are included to represent the departure from spherical symmetry round each carbon atom. The charge was used to calculate the structure factors which appear in the X-ray reflections and these calculated structure factors were compared with recent experimental values. To some extent, both the fine details of the strong lines and the presence of the so-called "missing reflection" 222 are accounted for on the present theory.

20527 THE STRUCTURE OF GRAPHITE.

T.Anno and C.A.Coulson.

Proc. Roy. Soc. A, (GB), Vol. 264, No. 1317, 165-75 (1961).

An investigation is made of the stability of a graphite layer, several possible types of deformation being considered. In the first mode of deformation the lengths of all three bonds starting from any atom in the layer are different, while the translation symmetry of the hexagonal configuration within a layer is still maintained. In the second, alternate hexagons remain regular, but the lengths of the bonds joining them differ from the lengths of the bonds in a hexagon. It is found that there are two types within this category. No account is taken of the interaction between layers. The calculation is based on the Hückel version of the molecular-orbital method for the π-electrons, with inclusion of an energy term representing the compression of the σ-bonds. It is shown that for all three types of deformation, with reasonable numerical values for the parameters, the regular configuration usually adopted does indeed correspond to an absolute minimum of the total energy with respect to these modes of deformation.

20528 NEUTRON DIFFRACTION STUDY OF THE CRYSTALLINE STRUCTURE OF SOLID HYDROGEN AND DEUTERIUM.

V.S.Kogan, B.G.Lazarev, R.P.Ozerov and G.S.Zhdanov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1022-6 (April, 1961).
In Russian.

Neutron diffraction analysis at 12°K has confirmed the structure of deuterium and the tetragonal variant of the hydrogen structure, as found by X-ray diffraction methods. For neutrons, the diffraction patterns were found to be considerably richer than for X-rays, for both hydrogen and deuterium. This is due, in the first place, to the appearance of interferences at angles greater than those for which the intensity of the X-ray interferences, which falls rapidly with increasing scattering angle, decreases to zero, and, in the second place, to the occurrence in the neutron diffraction patterns of interferences having odd index sums, which are forbidden for body-centred structures made up of identical particles. The latter may be accounted for, if it is assumed that the ortho- and para-molecules are distributed through the lattice in an ordered manner, and have different neutron scattering cross-sections. In certain cases interferences were observed at small angles, to which indices may be assigned by preceeding from the assumption that the ortho- and para-molecules are ordered within a volume containing eight cells. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 718-21 (Oct., 1961)].

THE STRUCTURE OF NICKEL DEPOSITS BY CATHODE SPUTTERING. See Abstr.19770

20529 ELECTRON DIFFRACTION STUDIES ON SOLID α-NITROGEN.

E.M.Hörl and L.Marton.
Acta cryst. (Internat.), Vol. 14, Pt 1, 11-19 (Jan. 10, 1961).

A technique was developed for studying thin films of solidified permanent gases by means of electron transmission diffraction. It was applied to the investigation of thin films of solid α-nitrogen at 4 and 20°K. The orientation of the microcrystallites on aluminum and Formvar substrates was investigated as a function of both the temperature of the substrate and the intensity of the molecular nitrogen beam during deposition. Further, the crystal structure and the cell dimensions of α-nitrogen were reinvestigated. Faults in the stacking sequence of (111) planes, detected under certain conditions, were studied in some detail. Preferential crystal growth processes were observed to be induced by electron bombardment. The influence of conditions of deposition on these processes was also investigated.

20530 STRUCTURE OF δ-PLUTONIUM.

J.A.C.Marples and J.A.Lee.
Nature (GB), Vol. 191, 1391 (Sept. 30, 1961).

In a recent article [by Konobeevsky and Chebotarev, Atomnaya Energiya (USSR), Vol. 10, No. 1, 50 (1961)] a modification to the normally close-packed f.c.c. structure was suggested consisting of slight displacements inwards of the force-centring atoms in alternate cells. This should result in additional weak "superlattice" lines on an X-ray diffraction pattern. The authors, using apparatus which was amply sensitive, failed to detect the presence of these lines.

20531 THE CRYSTAL AND MOLECULAR STRUCTURE OF S_6 (SULFUR-6).

J.Donohue, A.Caron and E.Goldish.
J. Amer. Chem. Soc., Vol. 83, No. 18, 3748-51 (Sept. 20, 1961).

An X-ray crystallographic study of rhombohedral sulphur was carried out. The crystals consist of hexameric molecules, S_6, with symmetry $\bar{3}m$. Fourier and least squares refinement of the atomic parameters give the following structural quantities: S—S bond length, 2.057 ± 0.018 A, S—S—S bond angle, 102.2 ± 1.6°, S—S—S—S torsion angle, 74.5 ± 2.5°. These values are compared with those found in orthorhombic sulphur, S_8, and are used in a discussion of the potential function for rotation about the S—S bond together with the S—S—S bending force constant.

20532 FORBIDDEN REFLECTIONS IN ELECTRON DIFFRACTION PATTERNS OF EVAPORATED TIN FILMS.

R.W.Vook.
J. appl. Phys. (USA), Vol. 32, No. 11, 2474-5 (Nov., 1961).

Previous work (Abstr. 11592 of 1961) showed the existence of some structurally forbidden reflections in the electron diffraction patterns of (100) oriented polycrystalline films, deposited under ultra-high vacuum conditions. A continuation of this work has resulted in the observation of these and other forbidden reflections in the diffraction patterns of two other kinds of film: (001) oriented single crystals containing deformation twins and (100) oriented single crystals. The existence of these strong reflections is probably due to strong dynamic interactions between the electron beam and the crystal lattice.

20533 THE STRUCTURE OF CRYSTALLINE URANIUM.

A.H.Cash, E.W.Hughes and C.C.Murdock.
Acta cryst. (Internat.), Vol. 14, Pt 3, 313-14 (March 10, 1961).

LATTICE CONSTANTS OF NH_4Br, RbBr AND RbCl. See Abstr. 19724

20534 HIGHLY ORIENTED BORON NITRIDE.

D.Belforti, S.Blum and B.Bovarnick.
Nature (GB), Vol. 190, 901 (June 3, 1961).

Boron nitride was obtained by pyrolytic deposition on a hot target. The crystallites have their basal planes parallel to the target plane; the crystallite size is ~ 140 A; the c-axis is 6.72 A, cf. 6.66 A in normal BN. A.R.Stokes

20535 LATTICE PARAMETER AND DEFECT STRUCTURE OF CADMIUM OXIDE CONTAINING FOREIGN ATOMS.

A.Cimino and M.Marezio.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 57-64 (Dec., 1960).

The incorporation of additives (In^{3+}, Ag^{+} or Na^{+}) into cadmium oxide was studied by means of precision measurements of the lattice parameter a. It is found that a varies linearly with $N^{1/3}$, where N is the concentration (atoms %) of additive. When In is added, a increases. The straight line obtained in the plot of a versus $N^{1/3}$, however, does not extrapolate to the value of a of the pure oxide, but to a lower value. Initially, therefore, addition of In must decrease the lattice parameter. The result is interpreted as pointing to two distinct mechanisms of incorporation The first mechanism (1) holds for the first fraction (~ 0.02 %) of addition, and corresponds to the elimination of interstitial cadmium excess, with consequent decrease of a. The second mechanism (2) is a controlled valency process, which corresponds to a decrease of valency of cadmium ions, with consequent increase of a. Addition of Ag leads to a contraction of a. The result is explained by a mechanism as in (2), except that the addition will cause an increase of valency, with consequent decrease of a. The possibility of alternate mechanism is discussed. An excess of cadmium of the order of 0.01% is inferred from the results. A thermal expansion coefficient of 1.35×10^{-5} (deg C)$^{-1}$ is determined from lattice parameter measurements at different temperatures.

CRYSTAL STRUCTURE OF PHOTOELECTRIC FILMS OF CAESIUM ANTIMONIDE. See Abstr. 16382

20536 AN ELECTRON-DIFFRACTION STUDY OF THIN FILMS OF CUPROUS IODIDE.

R.N.Kurdyumova and R.V.Baranova.
Kristallografiya (USSR), Vol. 6, No. 3, 402-5 (May-June, 1961).
In Russian.

Electron-diffraction patterns were recorded for thin films of CuI prepared by vacuum evaporation; a new and previously unknown hexagonal modification was detected, whose structure is described by a = 4.25, c = 20.86 A, space group C_{3v}^{1}, Z = 6. The structure is based on a six-layer ABABAC packing for the iodine atoms, in which the copper atoms take up alternate layers of tetrahedral holes. The new form goes over to the cubic γ modification (which is stable at room temperature) when it is annealed at 100-120°C. The hexagonal form of CuI has an exceptionally high electrical conductivity (about 10 ohm^{-1} cm^{-1}). [English translation in: Soviet Physics—Crystallography (USA). Vol. 6, No. 3, 318-21 (Nov.-Dec., 1961)].

20537 THE STRUCTURE OF SILVER OXIDE DETERMINED BY MEANS OF NEUTRON DIFFRACTION.

V.Scatturin, P.L.Bellon and A.J.Salkind.
J. Electrochem. Soc. (USA), Vol. 108, No. 9, 819-22 (Sept., 1961).

The crystal structure of AgO was determined by means of eutron diffraction. The nuclear scattering of Ag and O atoms has ade it possible to determine the positions of the oxygen atoms ad to modify the space group which was reported for this ompound from X-ray data. No magnetic diffractions were observed even at liquid-helium temperature; the absence of magnetic cattering confirms the diamagnetism of the compound. The ttice was found to be monoclinic, space group $P2_1/c$, with four rmula weights of AgO in the unit cell. The silver atoms are ot equivalent, and in the structure there are two Ag—O distances 2.18A and 2.03A; the first one corresponds to collinear g(I)—O bonds, the second distance corresponds to square planar g(III)—O bonds.

20538 ELECTRON DENSITY DISTRIBUTIONS IN ZnO CRYSTALS. G.P.Mohanty and L.V.Azároff.

. chem. Phys. (USA), Vol. 35, No. 4, 1268-70 (Oct., 1961).

Electron density distributions were determined for two ZnO rystals that had been heated in Zn vapour and for an undoped rystal by very accurate measurements of their X-ray diffraction ntensities. An examination of the difference between the electron ensities of doped and undoped crystals shows that the doped crystals ontain 15-60 × 10^{19} atoms/cm^3 in the octahedral interstices. The ncorporation of this large number of interstitial Zn atoms increases he axial ratio of the hexagonal unit cell from 1.6019 to 1.6025. The density of interstitials is approximately 1000 times greater than hat calculated from the electrical conductivity of these crystals so hat it must be concluded that most of the interstitial Zn atoms are electrically neutral. The presence of these interstitials explains why the time required to reach saturation for electrical conductivity s much greater in virgin crystals than in previously doped ones.

20539 LATTICE SPACINGS AND COLOUR IN THE SYSTEM ALUMINA—CHROMIC OXIDE. J.Graham.

J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 18-25 (Dec., 1960).

Precision lattice spacing determinations were made on well crystallized specimens throughout the system, and the diffuse reflectivity of the samples measured. There is no anomaly at 8 mol % Cr_2O_3 as found by earlier workers, the change in both the colour and the crystal field surrounding the chromium ions being continuous and smooth, though changes in the crystallographic environment of these ions cannot be followed in detail. Atomic parameters were obtained for pure chromic oxide, revealing that the structure is rather less distorted than the similar structures of α-alumina and α-Fe_2O_3.

20540 A DIFFRACTION MEASUREMENT OF THE STRUCTURE OF Cu_2O FILMS GROWN ON COPPER. B.Borie.

Acta cryst. (Internat.), Vol. 13, Pt 7, 542-5 (July, 1960).

A method for the detection of the Bragg maxima of very thin (100-500 A) oxide films grown on metals is described. The shapes of the maxima are interpreted to give the strain present in the film and its thickness. The method is illustrated by its application to Cu_2O grown on a 110 face of a copper single crystal.

20541 NEUTRON DIFFRACTION STUDY OF SOLID DEUTEROAMMONIA. J.W.Reed and P.M.Harris.

J. chem. Phys. (USA), Vol. 35, No. 5, 1730-7 (Nov., 1961).

The crystal structure of the stable cubic modification of solid deuteroammonia was determined by neutron diffraction. The space group is $P2_13-T^4$, and at −196°C the positions of the atoms are 4N at (a) with u = 0.2127 ± 0.0021 and 12D at (b) with x = 0.3740 ± 0.0019, y = 0.2632 ± 0.0037, and z = 0.1094 ± 0.0016. Each nitrogen atom is hydrogen bonded to the six nearest neighbour nitrogen atoms. There is one deuterium atom per site, in constrast to the "half-hydrogen" structure of ice. The N—D bond length of 1.005 ± 0.023 A is indistinguishable from that of the free molecule, while the D—N—D bond angle of 110.4° ± 2.0° is appreciably larger than the free molecule value.

20542 MANGANESE RARE EARTH COMPOUNDS WITH THE $MgZn_2$ STRUCTURE. J.H.Wernick and S.E.Haszko.

J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 207-9 (Feb., 1961).

Two new AB_2 compounds, $ErMn_2$ and $TmMn_2$ having the $MgZn_2$ structure are reported. The transition from the cubic Mn rare earth compounds to the hexagonal compounds is discussed. Crystallographic data for these two compounds and for $HfMn_2$ having the same structure are reported.

20543 A BENT HYDROGEN BOND MODEL FOR THE STRUCTURE OF ICE-I. R.Chidambaram.

Acta cryst. (Internat.), Vol. 14, Pt 5, 467-8 (May, 1961).

A bent hydrogen-bond model for the structure of ice-I is proposed which uses a value for the H—O—H angle close to the vapour value of 104½°. It is shown that while it is at least as consistent with the neutron-diffraction data of Peterson and Levy [Acta cryst. (Internat.), Vol. 10, Pt I, 70 (Jan., 1957) and Abstr. 2886 of 1959] as the "half-hydrogen" Pauling model, it is to be preferred from bond energy and spectroscopic considerations.

20544 THE CRYSTAL STRUCTURE OF La_3Co. D.T.Cromer and A.C.Larson.

Acta cryst. (Internat.), Vol. 14, Pt 12, 1226-8 (Dec. 10, 1961).

The crystal structure of La_3Co was determined by single crystal methods. There are four formula units in an orthorhombic cell, space group Pnma, with a = 7.279, b = 10.088 and c = 6.578 A. The compound is isostructural with Al_3Ni and Fe_3C.

20545 CRYSTAL STRUCTURE DISTORTIONS IN MnO_2 AND MnF_2 AT THEIR ANTIFERROMAGNETIC CURIE TEMPERATURE. S.L.Strong.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 51-3 (April, 1961).

Using a back-reflection Debye powder camera, X-ray photographs were taken of MnO_2 and MnF_2 to determine the behaviour of the lattice constants near the Néel temperature. It was found that on lowering the temperature the c-axis of MnO_2 expands while that of MnF_2 contracts. Examination of the results for MnO_2 and MnF_2 as well as other antiferromagnetics, shows that within a given structure there is a correlation between the distortion and the spin direction.

SOME PROPERTIES OF TITANIUM SESQUIOXIDES CONTAINING VANADIUM IONS. See Abstr. 17640

20546 THE CRYSTAL STRUCTURE OF THE INTERMETALLIC COMPOUND $ZrZn_{22}$. S.Samson.

Acta cryst. (Internat.), Vol. 14, Pt 12, 1229-36 (Dec. 10, 1961).

A complete determination of the crystal structure of the binary intermetallic compound most rich in zinc, the ξ-phase, in the zirconium—zinc system was carried out using all intensity data obtainable from single crystal Weissenberg photographs taken with Cu Kα radiation. The composition of the completely ordered phase is $ZrZn_{22}$. The refinement of the structure was carried out by application of the method of least-squares. The space group is O_h^7—Fd3m with 184 atoms per unit cube. The edge of the cubic unit cell determined with use of powder samples was a_0=14.101 ± 0.002 A. The truncated tetrahedron, the icosahedron, and the hexagonal prism are prominent coordination polyhedra in this structure. An analysis of these polyhedra reveals that the packing of atoms around the crystallographically different zinc atoms varies widely.

20547 THE ELECTRON DISTRIBUTION IN THE AMMONIUM ION. K.E.Banyard and N.H.March.

Acta cryst. (Internat.), Vol. 14, Pt 4, 357-60 (April 10, 1961).

Recent X-ray results of McDonald (Abstr. 8205 of 1960) on the electron distribution in ammonium bifluoride may be summarized in terms of a model in which the electron density in the ammonium ion is represented to reasonable accuracy as a central spherical charge cloud containing six electrons around the N nucleus, plus four unperturbed hydrogen electron distributions centred not on the protons but inwards along the N—H bonds. It is shown that the spherical average of the density in NH_4^+, calculated by Bernal and Massey (Abstr. 1307 of 1955) in connection with their work on metallic ammonium, may be well represented by the above model. However, it appears necessary to place the hydrogen distributions at a distance from the N nucleus which is (0.76 ± 0.06) of the N—H separation, compared with McDonald's value of (0.86 ± 0.03).

20548 SOME PROPERTIES OF COMPLEX OXIDES $AB_{0\cdot5}B'_{0\cdot5}O_3$ OF PEROVSKITE TYPE. S.Nomura and T.Kawakubo.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1642-3 (Aug., 1961).

X-ray and electrical conductivity measurements were made on oxides of the type $AB_{0\cdot5}B'_{0\cdot5}O_3$, where A = Ba, Sr; B = W, Mo; and B' = Ni, Co. These oxides have the perovskite structure and a rock-salt-type arrangement of the B and B' ions. The unit cell volume of the strontium oxides increased continuously with increasing Ba content and eventually a transition from tetragonal to cubic structure occurred. Electrical conductivity measurements indicate that this transition can also be induced by merely raising the temperature. J.Holt

20549 MOLECULAR STRUCTURE OF $B_9H_{13}(CH_3CN)$.

F.E.Wang, P.G.Simpson and W.N.Lipscomb.

J. chem. Phys. (USA), Vol. 35, No. 4, 1335-9 (Oct., 1961).

A three-dimensional X-ray diffraction study of a single crystal of $B_9H_{13}(CH_3CN)$ yielded the complete structure, including hydrogen atom positions. The nine boron atoms form an icosahedral fragment, like the arrangement in $B_{10}H_{14}$ with one boron atom missing. The structure is consistent with the present form of the topological theory of boron hydrides and ions in that it has two BH_2 groups, and is related to an anticipated $B_9H_{14}^-$ ion in the same way that $B_{10}H_{12}(CH_3CN)_2$ is related to $B_{10}H_{14}^{-2}$ ion. The crystals are monoclinic, in the space group $P2_1/m$, and have two molecules in a unit cell having parameters a = 5.64, b = 9.22, c = 9.81 A and $\beta = 90^0 \pm$ ± 30 min.

20550 REFINEMENT OF THE B_9H_{15} STRUCTURE AND TEST FOR SOLID SOLUTIONS.

P.G.Simpson and W.N.Lipscomb.

J. chem. Phys. (USA), Vol. 35, No. 4, 1340-3 (Oct., 1961).

Refinement of the X-ray diffraction data for B_9H_{15} confirms the structure, establishes an X-ray criterion for crystal purity, and shows that the most difficult impurity to detect, namely, a possible B_8 hydride, is not present in amounts greater than about 5% or so. Taking all observations of the X-ray investigations together, it is concluded that the B_9H_{15} single crystals were essentially pure.

20551 THE STRUCTURE OF BARIUM SILICATES.

A.N.Lazarev, T.F.Tenisheva and R.G.Grebenshchikov.

Dokl. Akad. Nauk SSSR, Vol. 140, No. 4, 811-14 (Oct. 1, 1961). In Russian.

Infrared spectra of 2 $BaO.3\ SiO_2$ and the high temperature form of $Ba_2(Si_2O_6)$ are determined and discussed in relation to the structure of silicates and germanates with special reference to chain formation. [English translation in: Soviet Physics—Doklady (USA)]. R.F.S.Hearmon

20552 THE CRYSTAL STRUCTURE OF Bi_2Te_2Se.

J.A.Bland and S.J.Basinski.

Canad. J. Phys., Vol. 39, No. 7, 1040-3 (July, 1961).

The crystal structure of Bi_2Te_2Se was determined by X-ray single crystal methods. The unit cell is trigonal, space group $R\bar{3}m$ with hexagonal cell edges a = 4.28 ± 0.02 A, c = 29.86 ± 0.10 A, and there are three formula units per unit cell. The structure is of the C33 type and a comparison is made with other C33 structures, Bi_2Se_3, Bi_2Te_3, and Bi_2Te_2S. An important common feature of these compounds is that the atom at the centre of symmetry has a relatively large contact distance with each of its six Bi neighbours.

20553 TETRAGONAL DISTORTION IN COPPER MANGANITE—CHROMITE SYSTEM.

S.Miyahara, K.Muramori and N.Tokuda.

J. Phys. Soc. Japan, Vol. 16, No. 7, 1490 (July, 1961).

The copper manganite-chromite system was examined crystallographically to determine the combined effect of cupric and manganese ions placed in the tetrahedral and octahedral positions respectively, so that their distortion effects cancel one another. For $CuMn_2.aCr_aO_4$, $0 \leq a \leq 1$ the structure is cubic, but for $1 < a \leq 2$ a tetragonal structure with $c/a < 1$ co-exists with a cubic phase. In the cubic region lattice parameters depend on heat treatment,this dependence decreasing with increased Cr; in the two-phase region the tetragonal phase intensity decreases with Cr increase. J.W.Taylor

20554 THE PREPARATION AND CRYSTALLOGRAPHY OF FeNiN AND THE SERIES $Fe_{4-x}Ni_xN$.

R.J.Arnott and A.Wold.

J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 152-6 (Aug., 1960).

The system $Fe_{4-x}Ni_xN$, $0 \leq x \leq 4$, was investigated. In the range $0 \leq x \leq 3.33$, the compounds have the γ' (Fe_4N) structure; when $3.33 \leq x \leq 4$, a two-phase region $Ni_3M + M_4N$ exists. Calculation of X-ray line intensities from diffraction patterns of the series $Fe_{4-x}Ni_xN$ indicate that the first nickel atom replaces the iron on the corners of the unit cell and that additional nickel replaces iron in a random manner. At ratios of Fe:Ni close to 1 : 1 a new phase is formed having the approximate composition FeNiN. This phase can be assigned a primitive tetragonal cell having a = 2.830 A and c = 3.713 A. The iron and nickel atoms are ordered with iron atoms located at the corners of the unit cell and nickel atoms at the body centres. The nitrogen atoms apparently lie at the c-face centres.

20555 A LOW-TEMPERATURE STUDY OF SOME SIMPLE HYDROGEN-BONDED STRUCTURES.

I.Olovsson.

Ark. Kemi (Sweden), Vol. 16, Paper 38, 437-58 (1961).

A summary of a number of papers on individual compounds. In many simple inorganic compounds, hydrogen bonds play a major part in determining the arrangement in the solid state, but the crystal structures are in some cases unknown. This may be partly due to experimental difficulties, as many such substances are gases or liquids at ordinary temperatures. A study of the bonding system in these cases should be important in the development of a theory of the hydrogen bond. In more complicated compounds other factors affect the arrangement and make a detailed interpretation more difficult. Single-crystal X-ray studies were made on some of the addition compounds between ammonia and the ammonium halides. The structures of $NH_4Cl{\cdot}3NH_3$, $NH_4Br{\cdot}3NH_3$, $NH_4I{\cdot}3NH_3$, and $NH_4I{\cdot}4NH_3$ were investigated [Acta chem. Scand. (Denmark), Vol. 14, 1453, 1466 (1960)]. It became apparent that a single-crystal study of ammonia itself would be of interest in confirming the structure earlier obtained by powder methods and to improve the knowledge of atomic positions. The structures of NH_3 and ND_3 were then studied independently (Abstr. 4633 of 1960). The structure of ammonia hemihydrate, $NH_3{\cdot}\frac{1}{2}H_2O$, had previously been studied and the closely related compound, ammonia monohydrate, $NH_3{\cdot}H_2O$ (Abstr. 4634 of 1960) was therefore investigated. Finally, the partial resemblance of this structure to that of ice lead to a study of the structure of hydrogen peroxide dihydrate, $H_2O_2{\cdot}2H_2O$ [Acta chem. Scand. (Denmark) Vol. 14, 1325 (1960)]. Details of the work on each compound are described in the references. A summary of this work is given and some general aspects, particularly concerning the hydrogen bonds, are presented. The low-temperature apparatus is also described in some detail, as a complete description was not given in the separate papers.

20556 CRYSTAL DISTORTION IN SPINELS CONTAINING Mn^{3+} IONS.

K.S.Irani, A.P.B.Sinha and A.B.Biswas.

J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 101-11 (Dec., 1960).

The effect of chemical composition on tetragonal—cubic spinel transformations in the systems Mn_3O_4—$MgAl_2O_4$ and $MgAl_2O_4$—$MgAl_2O_4$ was studied by X-ray diffraction. The unit cell dimensions of the various compounds were determined at room temperature. The c' and a' values do not change linearly with composition but show an abrupt change at a critical composition, beyond which c' = a', and the systems have the cubic spinel structure. The cation distribution was worked out from an analysis of the X-ray diffraction intensities, and thus a correlation between the actual number of distorting Mn^{3+} ions at the octahedral sites, and the degree of distortion, was obtained. The critical number of Mn^{3+} ions required at these sites to maintain the tetragonal spinel structure at room temperature is accurately determined.

20557 THE CRYSTAL STRUCTURE OF $Na_2Ti_3O_7$.

S.Andersson and A.D.Wadsley.

Acta cryst. (Internat.), Vol. 14, Pt 12, 1245-9 (Dec. 10, 1961).

The crystal structure of $Na_2Ti_3O_7$ was determined, using single-crystal methods. The space group is $P2_1/m$, with the unit-cell dimensions a = 8.571, b = 3.804, c = 9.135 A, $\beta = 101.57^0$. The structure consists of layers of the composition $(Ti_3O_7)^{2-}$. These are built up from blocks of six TiO_6 octahedra sharing edges, which are joined by having octahedral corners in common. The layers are held together by sodium ions which occur in two different kinds of crystallographic site.

20558 A NOTE ON THE STRUCTURE OF NON-FERRO-ELECTRIC LEAD METATANTALATE [$PbTa_2O_6$].

R.V.Coates.

Acta cryst. (Internat.), Vol. 14, Pt 1, 84 (Jan., 1961).

20559 ELECTRON DISTRIBUTION IN $KMnF_3$, $KFeF_3$, $KCoF_3$, AND $KNiF_3$.

A.Okazaki and Y.Suemune.

J. Phys. Soc. Japan, Vol. 16, No. 7, 1474 (July, 1961).

The structures of $KMnF_3$, $KFeF_3$, $KCoF_3$, and $KNiF_3$ at room temperature are of the cubic perovskite type, while that of $KCuF_3$ shows the Jahn—Teller distortion. For the former four compounds the (001) projections of the electron distributions are given. R.V.Coates

20560 ANOMALOUS TEMPERATURE DEPENDENCE OF LATTICE CONSTANTS OF FERROELECTRIC SODIUM NITRITE.

S.Hoshino and I.Shibuya.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1254-5 (June, 1961).

X-ray diffraction studies on single crystals show that the c-axis ecreases in length, while the a- and b-axes increase with increasing temperature. A transition at 1630°C was confirmed, and nother found at 178°C; the latter indicates the existence of an nknown phase between the ferro- and paraelectric phases.

J.H.Mason

20561 CRYSTAL GROWTH AND STRUCTURAL STUDY OF THE BARIUM-TITANIUM-PHOSPHATE PHOSPHOR.

.E.Harrison and G.Shirane.

. Electrochem. Soc. (USA), Vol. 108, No. 8, 788-90 (Aug., 1961).

Examination of single crystals and powder samples of the ompound $2BaO:TiO_2:P_2O_5$ revealed a reversible crystallographic nversion at 1040° ± 5°C. Both modifications have monoclinic ymmetry. The high-temperature form can be quenched and at oom temperature the lattice constants are $a_0 = 16.578$ A, $_0 = 5.437$ A, $c_0 = 4.756$ A, and $\beta = 94°0'$. The low-temperature hase can be indexed with very similar "basic" lattice constants, nd yet, for corresponding reflections the X-ray line intensities re quite different from those of the high-temperature form. However, doubling of the a_0 and c_0 parameters is required to account for veak extra spots which appear in single crystal photographs of the ow-temperature phase. Powder patterns of both phases were ndexed to 40° 2θ. Crystals grown from the melt were always winned with two types of twinning being distinguished. In one case he b-c plane and in the other case the a-b plane is the twin or omposition plane. Fluorescent emission spectra of the phases are dentical in shape, and they are characterized by a double peak. The spectrum of the high-temperature form lies about 0.02 eV oward longer wavelengths than does the low-temperature form.

X-RAY STUDIES OF $Ca_xBa_{1-x}TiO_3$ AND $Ca_xSr_{1-x}TiO_3$. See Abstr. 19930

STRUCTURE OF NON-STOICHIOMETRIC COPPER-MANGANESE FERRITE. See Abstr. 20131

THE ELECTRICAL PROPERTIES AND STRUCTURES OF COMPLEX OXIDE SEMICONDUCTORS. III. THE SYSTEMS $CuO—CoO—NiO—O_2$. See Abstr. 19884

20562 THE IONIC DISTRIBUTION IN THE GARNETS $Gd_3Al_3Fe_2O_{12}$ AND $Y_3Al_3Fe_2O_{12}$.

C.E.Miller.

J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 229-31 (Jan., 1961).

An analysis of quantitative X-ray powder diffraction intensity data was made with the purpose of determining the ionic distribution. It was found that the exact distribution cannot be determined in this manner. However, the distribution recently deduced by Geller (Abstr. 7766 of 1961), is compatible with the results of the X-ray analysis.

20563 THE DISTRIBUTION OF CATIONS IN A MULTICOMPONENT STOICHIOMETRIC SPINEL.

A.N.Men'.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1054-60 (April, 1961).

An expression is derived for λ, the equilibrium degree of inversion of the spinel

$$A_{1-c_3-c+\lambda}B_{c-\lambda}(A_{2-c_4-\lambda}B_{\lambda}D_{c_4})O_4.$$

The relation connecting λ, temperature and the parameters characteristic of a given spinel is investigated. For the ferrites of type $MeFe_2O_4$ (Me = Ni, Co, Fe), the following quantities are found: the change $\Delta\lambda$ and the change in the saturation magnetic moment, due to a change in the quenching temperature. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 767-71 (Oct., 1961)].

N.Davy

THE ELECTRICAL PROPERTIES AND STRUCTURES OF COMPLEX OXIDE SEMICONDUCTORS. II. THE SYSTEMS $MnO—CoO—NiO—O_2$ AND $MnO—CuO—NiO—O_2$. See Abstr. 19883

20564 THE CRYSTAL STRUCTURE OF NICKEL CHLORIDE HEXAHYDRATE, $NiCl_2.6H_2O$.

J.Mizuno.

J. Phys. Soc. Japan, Vol. 16, No. 8, 1574-80 (Aug., 1961).

The crystal structure of $NiCl_2.6H_2O$ was determined by the X-ray single crystal method. The unit cell is monoclinic with a = 10.23 A, b = 7.05 A, c = 6.57 A and $\beta = 122°10'$. The space group is C^3_{2h}—C2/m and the unit cell contains two formula units. The atomic arrangement is the same as that of $CoCl_2.6H_2O$ and thus the structure model adopted for this salt is again confirmed, as compared with the model proposed by Stroganov et al.

20565 INTERATOMIC DISTANCES AND THE NATURE OF THE Si—O BOND IN SILICATES.

M.G.Voronkov.

Dokl. Akad. Nauk SSSR, Vol. 138, No. 1, 106-9 (May 1, 1961). In Russian.

The Si—O bond in silicates is discussed in relation to electron configuration. It is concluded that there are three types of bond with respective lengths 1.73, 1.63 and 1.53 A. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 5, 367-9 (Oct., 1961)].

R.F.S.Hearmon

20566 THE CRYSTALLOGRAPHIC BASIC PARAMETERS OF NORMAL THALLIUM PHOSPHIDE Tl_2HPO_3.

M.Ebert and J.Šedivý.

Czech. J. Phys., Vol. 11, No. 1, 41-5 (1961). In German.

From the Laue diagram of disk-shaped single crystals there are three crystal classes of the trigonal system (32,3m, $\bar{3}$m) possible. By a rotating crystal method the parameters of the hexagonal unit cell were determined: a = 10.55 ± 0.02 A, c = 7.50 ± 0.01 A. By means of the elementary cell it was possible to assign all observed lines of a Debye—Scherrer diagram of powdery Tl_2HPO_3 to diffraction indices as shown in a table. The suggested elementary cell contains six molecules. The use of a smaller rhombohedral unit cell is not possible, therefore the rhombohedral space groups of the crystal classes mentioned above are excluded.

H.E.Schmid

20567 UNIT CELL DIMENSIONS OF YTTRIUM IRON GARNETS CONTAINING NEODYMIUM, PRAESODYMIUM AND LANTHANIUM IONS.

M.Schieber and Z.H.Kalman.

Acta cryst. (Internat.), Vol. 14, Pt 12, 1221-5 (Dec. 10, 1961).

Replacement of Nd, Pr and La for Y in iron garnets was studied. The unit cell dimensions varied from 12.380 A for $Y_3Fe_2O_{12}$ to 12.530 A in $[YNd_2]Fe_2Fe_3O_{12}$, 12.478 A in $[Y_2Pr]Fe_2Fe_3O_{12}$, and 12.434 A in $[Y_{2.5}La_{0.5}]Fe_2Fe_3O_{12}$ for the maximum amount of the lighter rare earth ions substituted for yttrium in iron garnets.

20568 CRYSTAL AND MOLECULAR STRUCTURE OF BIS (N N-DIETHYLDITHIOCARBAMATE)-COPPER (II).

A.Vaciago, C.Gramaccioli and A.Pullia.

Ricerca sci. (Italy), Vol. 30, No. 12, 2528-33 (Suppl. Dec., 1960). In Italian.

The authors present the first results of the determination of the crystal and molecular structure of bis (N, N-Diethyldithiocarbamate)-Copper (II). They emphasize similarities and differences between this compound and the analogous salts of Nickel (II) and Zinc(II). The data refer to projections normal to the axes [101] and [010]. The type of coordination of copper in this compound is discussed.

20569 THE POLYHEDRAL CLATHRATE HYDRATES. II. STRUCTURE OF THE HYDRATE OF TETRA ISO-AMYL AMMONIUM FLUORIDE.

D.Feil and G.A.Jeffrey.

J. chem. Phys. (USA), Vol. 35, No. 5, 1863-73 (Nov., 1961).

For Pt I, see Abstr. 3255 of 1960. The hydrate $[i-C_5H_{11}]_4N^+\cdot F^-\cdot 38H_2O$ belongs to a type of polyhedral clathrate structure in which the water molecules and the anions form the "host" structure and the cations are the "guests". The structural unit of the hydrogen-bonded clathrate cage is the $H_{40}O_{20}$ pentagonal dodecahedron. These dodecahedra are regularly associated in the crystal lattice by sharing faces, giving rise, therefore, to other polyhedra. In this hydrate, the other polyhedra are the tetrakaidecahedron and pentakaidecahedron, which form the cages enclosing the cations. A detailed three-dimensional single crystal structure analysis has been completed.

20570 CRYSTAL STRUCTURE OF NOR-HARMAN: A PRELIMINARY REPORT.

L.Ray.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 5, 478-9 (Sept. 26, 1960).

The crystal structure of nor-harman was determined by means of electron density projected on the (100) plane. The projection was solved by direct sign determining in the centro-symmetric plane-group pgg. Approximate y- and z-atomic co-ordinates are obtained. Further work on the refinement of the structure is in progress.

CRYSTAL STRUCTURE OF SHORT-CHAIN MONO-CARBOXYLIC ACIDS BY PROTON MAGNETIC RESONANCE. See Abstr. 20276

ALLOYS . METALLURGY

INFLUENCE OF ALLOY STRUCTURE ON THE TRANSFER OF MATTER. See Abstr. 16294

X-RAY SCATTERING IN ORDERING ALLOYS WITH A DISTORTED CRYSTAL LATTICE. See Abstr. 20492

CHANGES OF LATTICE SPACINGS IN ALLOYS AND THE SHAPE OF THE FERMI SURFACE. See Abstr. 17460

OBSERVATIONS ON THE OXYGEN SOLUBILITY AND MAGNETIC SUSCEPTIBILITY OF BODY-CENTRED CUBIC TRANSITION METAL ALLOYS. See Abstr. 20640

20571 LATTICE SPACING RELATIONSHIPS AND THE ELECTRONIC STRUCTURE OF H.C.P. ζ-PHASES BASED ON SILVER.

H.W.King and T.B.Massalski.
Phil. Mag. (GB), Vol. 6, 669-82 (May, 1961).

The lattice spacings of h.c.p. ζ-phases in the systems Ag—Cd, Ag—Hg, Ag—Ga, Ag—In, Ag—Sn, Ag—As and Ag—Sb were studied by the X-ray powder method. The results show consistent trends in the changes of lattice spacings when plotted as functions of electron: atom ratio. These trends may be interpreted in terms of distortions of the Brillouin zone following interactions between the Fermi surface with various zone faces. The results indicate that in Ag-based alloys the overlap of Fermi electrons across the {10.0} faces of the Brillouin zone occurs in the region of e/a between 1.39 and 1.40. The influence of particular solute elements on the changes in lattice spacings may be interpreted qualitatively by considering that the band gaps in the Brillouin zone of silver are decreased by the addition of the solute element.

20572 ZONE STRUCTURE OF ALUMINIUM—ZINC ALLOYS.

V.Gerold.
Phys. Status solidi (Germany), Vol. 1, No. 1, 37-49 (1961).
In German.

It is shown, by measuring the small-angle scattering on an absolute scale, that the concentration of Zn atoms inside and outside the spherical Guinier—Preston zones is a function of the ageing temperature only, and not of the initial concentration of the solid solution. This implies the existence of a metastable miscibility gap in the supersaturated solid solution. Using quantitative values of X-ray scattering from solutions containing 6 to 12 at.% Zn, the concentrations at the limits of the gap at room temperature were determined as $m_1 = 69.2$ at.% and $m_2 = 1.8$ at.%. Arguments are given which indicate that the miscibility gap develops in very short ageing times. These results can be explained only by use of a zone model involving two thermodynamically different phases. This is to be compared with the model postulated by Walker and Guinier [Acta metallurgica (Internat.) Vol. 1, 568 (1953)] which involves three different phases.

20573 LATTICE CONSTANTS OF Bi_2Te_3—Bi_2Se_3 SOLID SOLUTION ALLOYS.

J.R.Wiese and L.Muldawer.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 13-16 (Aug., 1960).

The Bi_2Te_3—Bi_2Se_3 quasi-binary system is rhombohedral for all compositions. Lattice constant a_0 and c_0 (based on a hexagonal lattice) for the entire range were determined using powder pattern film techniques. The constant a_0 follows Vergard's rule over the entire range of compositions, while the constant c_0 exhibits a positive deviation over the range from 40 mol.% Bi_2Se_3 to Bi_2Se_3. Bi_2Te_3 has a layered structure with planes of atoms of a single type parallel to the basal plane. The lattice constant data can be explained in terms of Se-atom substitution in preferred planes for the range Bi_2Te_3—Bi_2Te_2Se. Interlayer spacings for Bi_2Te_3 and Bi_2Te_2S are given and discussed.

CONTRIBUTION OF STRAIN TO NUCLEAR QUADRUPOLE INTERACTIONS IN DILUTE ALLOYS OF COPPER.
See Abstr. 17389

20574 THEORY OF X-RAY SCATTERING BY INTERSTITIAL SOLID SOLUTIONS.

M.O.Krȳvohlaz and O.O.Tȳkhonova.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No.2, 174-89 (1960). In Ukrainian.

General formulae are derived for the intensity of diffuse scattering of X-rays by interstitial solid solutions. It was shown that near the points of the reciprocal lattice the intensity of scattering may be expressed by derivatives of the lattice parameters of concentration, modulus of elasticity and thermodynamic quantities, which may be determined independently. A more detailed consideration is given to solutions in which the interstitial atoms are in the octahedral interstices of face-centred and body-centred cubic lattices, and to solutions of the martensite type. The properties of the form of isodiffusive surface in a reciprocal lattice were studied for various structures. The displacements of atoms around the interstitial atom of carbon in α-Fe are calculated, as well as the average quadratic displacements.

ON THE NEW MAGNETIC PHASE IN MANGANESE—ALUMINIUM—COPPER SYSTEM. See Abstr. 20664

20575 X-RAY AND ELECTRICAL INVESTIGATION OF SOLID SOLUTIONS IN THE SYSTEM $PbTiO_3$—$SrSnO_3$.

S.A.Fedulov, Yu.N.Venevtsev, G.S.Zhdanov and E.G.Smazhevskaya.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 959-63 (March, 1961).
In Russian.

The method of preparing the solid solutions is briefly described. The cell parameters a and c, the cell volume, and the axial ratio a/c are shown graphically as a function of composition, and the permittivity, loss tangent and conductivity as a function of composition and temperature. The phase diagram is established and the properties of the system are shown to be similar to those of the system $PbTiO_3$—$SrTiO_3$ which has a cubic paraelectric phase and a tetragonal ferroelectric phase. [English translation in: Soviet Physics—Solids State (USA), Vol. 3, No. 3, 695-8 (Sept., 1961)].

R.F.S.Hearmon

20576 DEGREE OF IONIZATION OF SILVER IN A SILVER-PALLADIUM ALLOY.

I.I.Kovenskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 10, 3239-41 (Oct., 1961).
In Russian.

From experimental data on electro-transport of Ag in a 30% Pd—Ag alloy, studied by the radioactive tracer (Ag^{110}) method, the effective charge of Ag ions, varying from −2.9 at 850°C to −1.8 at 1100°C, was determined. The charge of Pd ions, calculated from these data and from the electron density in the alloy studied, was found to be −0.3. [English translation in: Soviet Physics—Solid State (USA)].

M.H.Sloboda

20577 THE LATTICE SPACINGS OF THORIUM—LANTHANUM ALLOYS.

D.S.Evans, G.V.Raynor and R.T.Weiner.
J. nuclear Materials (Internat.), Vol. 2, No. 2, 121-8 (June, 1960).

The lattice spacing : composition curve for the thorium—lanthanum alloy system was investigated, for comparison with previous work on the thorium—cerium system. The stringent precautions necessary to minimize contamination (principally by nitrogen) are outlined. The results indicate that f.c.c. thorium and lanthanum form a complete series of solid solutions; the experimentally determined lattice spacings lie on a smooth and continuous curve, except for a narrow range of composition from about 52 to 60 at.% lanthanum, in which erratic results may be obtained. The reason for the scatter at these compositions is thought to lie in an enhanced solubility of nitrogen in the alloys. The lattice spacing curve obtained is not of the same forms as that for the thorium—cerium alloys, and the reason for this is discussed in terms of the relative ease with which cerium may change its effective valency in solid solution.

20578 LATTICE SPACINGS IN THORIUM—YTTRIUM ALLOYS.

D.S.Evans and G.V.Raynor.
J. nuclear Materials (Internat.), Vol. 2, No. 3, 209-15 (Sept., 1960).

Using all the precautions found to be necessary in previous work on the lattice spacings of very reactive alloy systems, the spacings for the f.c.c. and c.p.h. solid solutions based respectively on thorium and yttrium were measured at a temperature of 25°C, following annealing at 750°C. The lattice spacings observed for yttrium were a = 3.6441, c = 5.7358 kX. Solution of thorium increases the c-spacing and decreases the a-spacing. By contrast the lattice spacing of thorium is only very slightly affected by the solution of yttrium. From the results of the lattice spacing measurements, and from those of a metallographic examination, the two-phase region between the cubic and hexagonal solid solutions extends from 49 to 69 at.% yttrium. This is in conflict with the work of previous investigators (Eash and Carlson) and reasons for the discrepancy are discussed in terms of the effects of impurity on the relative stabilities of the two structures.

LATTICE PARAMETERS OF THE TiAl ALLOY.
ee Abstr. 20465

METASTABLE γ-PHASE URANIUM—MOLYBDENUM ALLOYS.
ee Abstr. 17450

20579 THE STRUCTURE OF AN INTERMETALLIC COMPOUND OF Zr. V.N.Bȳkov and V.V.Kazarnikov.
ristallografiya (USSR), Vol. 4, No. 6, 924-5 (Nov.-Dec., 1959).
n Russian.

The orthorhombic unit cell dimensions of $ZrBi_2$ are given: he diffraction symbol is mmm Pnn. [English translation in: oviet Physics—Crystallography (USA), Vol. 4, No. 6, 880-1 June, 1960)]. M.A.Taylor

20580 ON THE THERMODYNAMICS OF THE Au—Pt SYSTEM. J.L.Meijering.
J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 267-8 (Feb., 1961).

Previous work by Weiss and Tauer (Abstr. 3413 of 1959) in which they attempt to interpret the asymmetry of the Au—Pt miscibility gap in terms of specific heat data is discussed. It is shown that other undesirable features are introduced if it is assumed that the free energy at absolute zero is symmetric. One of the more serious features is the introduction of a miscibility gap at low Pt concentrations. A.E.Kay

CHANGE OF THERMAL CONDUCTIVITY OF SOME Cd—Sn AND Bi—Sn ALLOYS ON MELTING. See Abstr. 19730

20581 HYDROGEN IN ZIRCALOY-2: ITS DISTRIBUTION AND HEAT OF TRANSPORT. A.Sawatzky.
J. nuclear Materials (Internat.), Vol. 2, No. 4, 321-8 (Dec., 1960).

Two determinations of the heat of transport for hydrogen in zircaloy-2 were made under steady-state conditions over the temperature range 300° to 500°C. Values of 4.7 and 6.1 kcal/mole were obtained. Similar experiments on deuterium gave values of 6.2 and 6.8 kcal/mole. An equation has been developed giving the hydrogen concentration in the two-phase (alpha plus hydride) region as a function of time and temperature. On the basis of this equation, a model for the over-all hydrogen distribution under the influence of a temperature gradient is proposed. The model has been fitted to several experimental curves and the agreement found to be very good. The model predicts that for hydrogen pickup on the hot surface (as in a failure of a fuel-rod sheath) maximum hydriding will occur at some position displaced from the cold surface. This prediction is supported by observations made on a failed zircaloy-2-clad UO_2 fuel element.

20582 THE CRYSTALLOGRAPHY OF THE MARTENSITE REACTION IN STEEL. A.G.Crocker and B.A.Bilby.
Acta metallurgica (Internat.), Vol. 9, No. 7, 678-88 (July, 1961).

Computer programmes have been prepared and used to examine the crystallographic features of the martensite reaction in steels. The criteria of low or minimum values of the shape shear and the slip or twinning shear were used in assessing the predictions. The results show that the observed features cannot be explained by allowing either uniform dilatations of the interface of up to ±0.5%, or slip or twinning shears on low-indexed planes in low-indexed directions. More general additional deformations are discussed in which no dilatation is allowed but the slip or twinning shear occurs on two or more planes or in two or more directions, and a mechanism by which the observed $\{111\}_\gamma$ habit may be produced is suggested. A full explanation of the $\{259\}_\gamma$ and $\{225\}_\gamma$ habits, and of the observed scatter in the experimental results appears to require some extension of the theory.

20583 ON THE APPLICATION OF PHASE DIAGRAMS IN THE STUDY OF THERMODYNAMIC INTERACTIONS.
É.Bonnier and P.Desré.
C.R. Acad. Sci. (France), Vol. 252, No. 22, 3448-50 (May 29, 1961).
In French.

Generalization of the treatment of Abstr. 1435 of 1961 to the case where a solid solution exists. J.Hawgood

20584 PHASE DIAGRAM FOR THE PSEUDOBINARY SYSTEM $Ag_2Te—Sb_2Te_3$.
J.P.McHugh, A.W.Tiller, S.E.Haszko and J.H.Wernick.
J. appl. Phys. (USA), Vol. 32, No. 9, 1785 (Sept., 1961).

Solidus and liquidus curves are given, with some indications of phase boundaries at lower temperatures. H.Mykura

ON THE DECOMPOSITION OF THE FERROMAGNETIC PHASE OF THE HEUSLER ALLOY, Cu_2MnAl. See Abstr. 20114

STUDY OF THE Fe—C SYSTEM BY CONTINUOUS CALORIMETRY. See Abstr. 16174

TRANSFORMATIONS IN IRON AND IRON—CHROMIUM ALLOYS. See Abstr. 17607

20585 STUDY OF THE BASIC K-EDGE OF X-RAYS OF IRON AND VANADIUM ATOMS IN THEIR ALLOY IN TWO MODIFICATIONS. L.H.Nikolayeva and S.M.Karalnȳk.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 231-4 (1960). In Ukrainian.

The authors studied the position of the K-edges of absorption of X-rays by iron and vanadium atoms in their alloy in the α-and σ-modifications. For the middle region of alloy concentration a short-wave displacement of the K-edges from their position in the pure metals attains a maximum value of 4-5 eV. In the σ-phase the position of the K-edges proved more long-waved that in the α-phase. These results are similar to those obtained for alloys of iron with chromium in a analogous study. Thus, since the Fe—Cr and Fe—V systems are very similar, both with respect to the diagrams of state of phse transformation of the alloys and in respect to crystallochemical structure, it may be considered that the results obtained reflect a law, common for both systems, of the change in the electronic state of the component atoms during the formation of alloys and in phase transformation. The authors postulate that the $\alpha \rightarrow \sigma$ transformation is attended by the transfer of 3d-electrons of iron atoms to the outer levels of chromium and vanadium atoms. Considerations are cited substantiating this on the grounds of experimental data contained in the literature on X-ray emission spectra.

20586 CONSTITUTION OF LOW CARBON U—C ALLOYS. B.Blumenthal.
J. nuclear Materials (Internat.), Vol. 2, No. 3, 197-208 (Sept., 1960).

The uranium—carbon phase diagram at low carbon concentration was determined by saturation experiments, thermal analyses and metallography. The system has a eutectic point of 0.98 at.% carbon at 1116.6°C and two eutectoid reactions:

$$U_{(\gamma)} \rightleftharpoons U_{(\beta)} + UC \text{ and } U_{(\beta)} \rightleftharpoons U_{(\alpha)} + UC,$$

at 771.8°C, and 665.9°C, respectively, 3.0° and 1.8°C below the transformation temperatures of the pure metal. The gamma solubility decreases from 0.30 ± 0.075 at.% at the eutectic temperature to 0.09 ± 0.04 at.% at the eutectoid temperature. The solubility of carbon in beta uranium is probably less than 10 p.p.m. by weight, in alpha uranium less than 3 p.p.m.

20587 PROPOSED NOMENCLATURE FOR THE PHASES OF URANIUM ALLOYS. J.Lehmann and R.F.Hills.
J. nuclear Materials (Internat.), Vol. 2, No. 3, 261-8 (Sept., 1960).
In French and English.

Since the uranium—molybdenum system was first investigated by Ahmann, Snow and Wilson, the importance of these alloys as potential nuclear fuels has led to the accumulation of an extensive fund of information, unfortunately confused by a diversity of terminology. At a meeting held at Saclay between representatives of metallurgy laboratories associated with uranium alloy studies in France and England, an agreed basis of nomenclature was proposed. Although the nomenclature has special reference to uranium—molybdenum alloys, it is believed to be sufficiently general to cover equilibrium and metastable phases existing in all uranium systems showing solubility in the body centred cubic gamma phase.

20588 THE ENERGY OF ORDER IN ALLOYS. M.Shimoji.
J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 198-206 (Nov., 1960).

The energy of order in alloys is explained in terms of the electrostatic interaction of the charged atomic polyhedra. The present discussion does not use the assumption of the pairwise interaction of nearest neighbours which is doubtful in the problems of metals. This line of approach has been used by Mott only for the calculation of the energy of order in the completely ordered superlattice. However, the present discussion is extended to cover the order phenomena in the cases of the short-range as well as in those of the long-range (including those of the intermediate degree of order of superlattices). The charges of atomic polyhedra may be produced by electron transfer associated with the negative excess energy of the alloy, but the energy of these charges, being an origin of order in alloys, is only one part of the excess energy. The result shows that the discrepancy between experiment and theory could be removed in principle if the difference of the energy between the completely ordered state and the disordered were quantitatively calculated, and that the energy of order is not so simply related to the excess energy as in the usually accepted theories based upon the assumption of pairwise interaction of neighbours.

20589 ON ORDER—DISORDER PHENOMENA IN BINARY ALLOYS. A.Corciovei and D.Grecu.

Rev. de Physique (Roumania), Vol. 5, No. 3-4, 295-314 (1960).

A theoretical investigation of ordering in centred square and bodycentred cubic lattices of type AB is made. Taking into account only nearest neighbour interaction, it is concluded that at equilibrium the partial order in the two sublattices is different. Expressions for the critical temperature and specific heat are also obtained. The results are compared with those of other authors using different methods. H.Mykura

20590 MONTE CARLO CALCULATION OF THE ORDER—DISORDER TRANSFORMATION IN THE BODY-CENTERED CUBIC LATTICE. P.A.Flinn and G.M.McManus.

Phys. Rev. (USA), Vol. 124, No. 1, 54-9 (Oct. 1, 1961).

A critical temperature was observed at the point $(v/kT) = -0.315$. The results of the calculation are in close agreement with the best analytical approximations. The calculated variation of order with temperature is in good agreement with experimental data on β-brass and β-AgZn. Some information on the kinetics of the transformation was obtained. It appears likely that the rate-limiting process for diffusion in the ordered structure is jumping of vacancies to second neighbour positions.

ELECTRICAL RESISTIVITY OF METALLIC ALLOYS AS A FUNCTION OF ORDERING. See Abstr. 17600

ON THE THEORY OF ORDER—DISORDER (OD) STRUCTURES. See Abstr. 20483

20591 ORDER—DISORDER PHENOMENA IN α-BRASS. IV. NATURE OF ORDER AND ROLE OF ATOMIC MOBILITY. L.M.Clarebrough, M.E.Hargreaves and M.H.Loretto.

Proc. Roy. Soc. A (GB), Vol. 261, 500-15 (May 23, 1961).

For Pt I-III see Abstr. 1418-20 of 1961. On continuous heating of slowly cooled specimens of α-brass containing approximately 30, 25 and 20 at.% zinc there is a marked absorption of energy due to disordering. The range of temperature in which this absorption occurs is sensitive to the rate of heating and the zinc content. Similar characteristics are shown by a silver—zinc alloy containing 27 at.% zinc. On heating specimens of α-brass quenched from 600° C an evolution of energy results from the return of order and the rate of this evolution increases with increasing zinc content. However, for the silver—zinc alloy a constant absorption of energy occurs from approximately room temperature. The degree of disorder retained at room temperature in the quenched specimens of α-brass decreases as the zinc content increases and for the silver—zinc alloy the quenched specimen is more ordered at room temperature than a slowly cooled specimen. The influence of composition on the ΔP curves of both slowly cooled and quenched specimens of α-brass is related to the increase in atomic mobility with increase in zinc content. Similarly the difference between the copper—zinc and silver—zinc alloys is due to the higher atomic mobility in the silver—zinc alloy. It is concluded that the absorption of energy observed in the copper—zinc alloys is due to the destruction of short-range order and that the critical temperature is less than 75° C.

SHORT RANGE ORDER IN Fe—Al ALLOYS. See Abstr. 19828

20592 LONG-RANGE ORDER IN Fe—Al ALLOYS. II. THERMOELECTRIC POWER.

G.Erez and P.S.Rudman.

J. Phys. Chem. Solids (GB), Vol. 18, No. 4, 307-15 (March, 1961).

For Pt I see Abstr. 16348 of 1960. The thermoelectric power (TEP) relative to copper was measured in Fe—Al alloys: (a) for the alloy 25.05 at.% Al over the temperature range 100-950° C; (b) at room temperature over the composition range 17.0-28.5 at.% Al as a function of quenching temperature. The critical temperature for the Fe$_3$Al structure was marked by a sharp change in slope of the TEP versus temperature plot and the phase boundary was accordingl determined; for stoichiometric Fe$_3$Al, $T_c = 560 \pm 5^{0}$ C. The critical temperature of the FeAl structure was not marked by a similar change in slope; however, a change in slope of the TEP versus composition plot defines this transformation. Fe$_3$Al order acts to increase while FeAl order acts to decrease the TEP. The results are interpreted in terms of distortion of the density of state curve of the 4s band due to the formation of new Brillouin zones accompanying ordering. The results are discussed in terms of the change on ordering of the kinetic energy of the 4s electrons as being the origin of the ordering energy for the Fe$_3$Al.

20593 THEORY OF X-RAY SCATTERING BY ORDERED ALLOYS. V.M.Danȳlenko.

Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 203-11 (1960). In Ukrainian.

Deals with alloys with domain structure of ordering. For the case of completely ordered alloys with the composition AB, formulae were developed for the intensity and form of Bragg reflections. In the presence of domain structure the superstructural reflections are wider, with the width of the reflections inversely proportional to the average value of the domain dimensions. In the case of a one-dimensional system of domain boundaries, the broadening takes place in a direction perpendicular to the boundary planes. Three-dimensional domains involve three-dimensional broadening.

20594 DIRECT OBSERVATION OF ANTIPHASE BOUNDARIES IN THE AuCu$_3$ SUPERLATTICE.

R.M.Fisher and M.J.Marcinkowski.

Phil. Mag. (GB), Vol. 6, 1385-1405 (Nov., 1961).

Antiphase domains were revealed for the first time in fully and partially ordered AuCu$_3$ by transmission electron microscopy of foils prepared by electro-thinning bulk samples. The domains are observed to form a network of rectangular blocks, the boundaries of which lie on cube planes. In addition, it is concluded that alloys annealed for long periods just below the critical ordering temperature consist of imperfectly ordered domains within which the order is homogeneous. It has been shown both theoretically and experimentally that in order to observe the domain structure, the ordered crystal must be oriented for diffraction contrast by a strong superlattice reflection. All of the various types of domain-boundary contrast seen in the electron micrographs can be explained by application of the dynamical theory developed by Whelan and Hirsch (Abstr. 8950 of 1957) for the contrast of stacking faults when the appropriate phase angle and extinction distances for superlattice reflection are introduced. The agreement between theory and experiment is very good. The extinction distances of the superlattice reflection involved in the domain boundary contrast are found to be about four times that of normal reflections causing stacking-fault contrast. The maximum deviation from the Bragg angle at which the domain boundaries can still be observed is only about one-fourth that for stacking faults. Another consequence of the present theory is that not all of the domain boundaries present can be observed for any one strong superlattice reflection, and this effect causes an apparent intricate maze pattern of antiphase domains in many of the micrographs.

20595 THE DIRECT OBSERVATION OF ANTIPHASE BOUNDARIES IN THE Fe$_3$Al SUPERLATTICE.

M.J.Marcinkowski and N.Brown.

Phil. Mag. (GB), Vol. 6, 811-13 (June, 1961).

Transmission electron microscopy shows two distinct types of antiphase boundaries to be associated with the two possible ordering systems. M.A.Taylor

20596 THE SUPERSTRUCTURES OF IRON SELENIDE Fe$_7$Se$_8$. A.Okazaki.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1162-9 (June, 1961).

Iron vacancies in Fe$_7$Se$_8$ are confined to the alternate iron layers parallel to the c plane of the fundamental lattice with NiAs structure. The origin of the ferrimagnetism of Fe$_7$Se$_8$ ($T_C = 187^{0}$C) may be attributed to this ordered arrangement similarly to the case of Fe$_7$Se$_8$. There are two types of the superstructure: low- and high-temperature ones. The unit cell dimensions and the lattice symmetries of these structures are as follows:

low-temperature type: $A = \sqrt{3}B$, $B = 2a$, $C = 4c$, triclinic,
high-temperature type: $A = 2a$, $C = 3c$, hexagonal,

where the capital and small letters designate the super- and fundamental lattices, respectively. The transition from the triclinic ructure to the hexagonal one, which means a rearrangement of the on vacancies, begins at 240°C, proceeds gradually and finishes at 8°C.

20597 MEASUREMENT OF THE STORED ENERGY RELEASE IN METAL FILMS CONDENSED BY LOW-TEMPERATURE QUENCHING. W.Mönch.

Phys. (Germany), Vol. 164, No. 2, 229-42 (1961). In German.

Metal films are produced with a high degree of disorder by quenching condensation. The stored energy release and the resistivity decrease were measured during annealing of Au, Pb, and Sn films from 20 to 60°K and during crystallization of amorphous Sn films with a 10 atomic-% Cu content. The results re compared with earlier measurements on Bi, Ga, and Cu films produced by quenching condensation. The energy released during he crystallization of the amorphous films (Bi, Ga, Sn + 10 at.% Cu) amounts to half of the heat of melting. This is in good agreement with calculations of Oriani (Abstr. 4336 of 1951) and Lumsden Inst. Metals Monograph Ser. No. 11) for the disorder part of the entropy of melting. The recovery of the crystalline Cu, Au, Pb, and Sn films is described by the crystallization of highly disordered atoms to crystallites formed during condensation. About 30% of All the atoms of these films are in this highly disordered state.

THE DEFORMATION OF SINGLE CRYSTALS OF ALUMINIUM-4.5% COPPER ALLOY IN SEVERAL HEAT-TREATED CONDITIONS. See Abstr. 20369

20598 SEGREGATION OF SOLUTE ATOMS IN Cu—Al ALLOYS. K.Nakazima and S.Koda.

Phil. Mag. (GB), Vol. 6, 823-4 (June, 1961).

The line profile of powder diffraction lines was used to study the segregation of solute atoms in Cu—18.3% Al. R.F.Peart

20599 MATHEMATICS OF DIFFUSION-CONTROLLED PRECIPITATION IN THE PRESENCE OF HOMOGENEOUSLY DISTRIBUTED SOURCES AND SINKS.

L.A.Girifalco and D.R.Behrendt.

Phys. Rev. (USA), Vol. 124, No. 2, 420-7 (Oct. 15, 1961).

The growth-rate equations are derived for diffusion-controlled precipitation while the diffusing species is continually being created and destroyed throughout the material. Three mechanisms are treated: (1) bulk diffusion from a large spherical region to a small, concentric spherical particle; (2) diffusion in a spherical region to the wall of the sphere and subsequent instantaneous diffusion to a precipitate particle on the sphere's surface; and (3) two-dimensional diffusion in a circular region to a spherical particle located at the centre of the circle. Ham's method (Abstr. 8972 of 1959), in which the concentration is expanded in eigenfunctions of an appropriate eigenvalue problem is extended to take into account the presence of sinks and sources. The resulting equations were solved with the aid of a digital computer. The results show that, in the short-time approximation, the radius is proportional to the time for case (1), the radius is proportional to the cube root of the time for case (2), and the radius shows a rapid rise at very short times and then a slower, almost linear increase with time for case (3). For long times, the shape of the radius—time curves is more complex.

20600 RESISTIVITY CHANGES DUE TO FORMATION OF G.P. ZONES (CLUSTERS RICH IN SOLUTE).

H.Herman and J.B.Cohen.

Nature (GB), Vol. 191, 63-4 (July 1, 1961).

Resistance and small-angle scattering X-ray measurements were carried out during the ageing of an Al—5.3 at. % Zn alloy to test whether the maximum in resistance which occurs during ageing is associated with a zone of definite size. Specimens were quenched from 300°C into water at 25°C and aged at either 0°C or 30°C. X-ray measurements were made at the resistance peaks with the specimen held at −195°C to interrupt ageing. The results indicate that the peaks were associated with zones of about 10 A average diameter, agreeing reasonably well with theory. A.E.Kay

20601 OBSERVATIONS OF PRECIPITATION IN THIN FOILS OF ALUMINIUM + 4% COPPER ALLOY.

G.Thomas and M.J.Whelan.

Phil. Mag. (GB), Vol. 6, 1103-14 (Sept., 1961).

A high-temperature specimen stage was used to study precipitation in thin foils of Al + 4% Cu alloy directly in the electron microscope. Precipitates a few hundred angstroms in size were observed to form in a few minutes at temperatures ~250° to 300°C. This initial precipitation was identified by electron diffraction as the θ' phase, and is found to occur in a well-defined single orientation with respect to the matrix. The orientation observed is consistent with one of those of θ' formed in bulk material. The growth at higher temperatures of larger θ precipitates at the expense of the θ' precipitates has also been studied. The results show that precipitation in thin foils differs from that in bulk material due to the fact that the surfaces act as preferential nucleation sites. Most of the precipitates in the thin foils appear to be at the surfaces. In aged bulk material preferential precipitation occurs on helical dislocations formed from screw dislocations by vacancy climb. The precipitates are observed to go into solution at ~500°C. Measurement of the rate of dissolution by ciné techniques has enabled an estimate of the diffusion coefficient of copper in aluminium to be made. Other observations include the formation of regions denuded of small precipitates near grain boundaries and large precipitates, and the growth and dissolution of precipitates under a fluctuating temperature.

20602 PRECIPITATE HARDENING IN AN ALUMINIUM—COPPER ALLOY. J.G.Byrne, M.E.Fine and A.Kelly.

Phil. Mag. (GB), Vol. 6, 1119-45 (Sept., 1961).

In Al—1.7 at.% Cu the critical resolved shear stresses (c.r.s.s.), tension stress—strain curves, and the dependence of the flow stress on strain rate were determined from 4.2 to 273 or 373°K for the following structures: supersaturated α solid solution, α + GP I, α + GP II, $\alpha + \theta'$, and $\alpha + \theta$ (GP I and GP II denote Guinier—Preston zones of the first and second kinds). The difference between the c.r.s.s. at 4.2 and 273°K is large for the first two structures, but small with GP II, θ' or θ precipitates. With α, α + GP I, and α + GP II, a single slip system is operative over a significant portion of the stress—strain curve, and the rate of work hardening is about the same as that for pure Al. With θ or θ' multiple slip is immediately detected beyond the yield stress, the work-hardening rates are initially extremely rapid, and fall to small values after some percent strain so that a plateau occurs in the stress—strain curves. For supersaturated α, the strength is attributed to clustering in the solid solution. In the cases of α + GP I and α + GP II, the zones must be sheared during plastic deformation and the strengthening arises from the atomic scrambling which occurs and the local strains near a zone which must be overcome when a dislocation moves through a zone. The variation of critical resolved shear stress with temperature and the strain-rate data are discussed in terms of the theory of thermally activated slip. Activation energies computed from the data are larger than those predicted on the basis of atomic scrambling alone. With θ' or θ precipitate dislocations bend between the particles.

20603 AN ELECTRON MICROSCOPE EXAMINATION OF SMALL COBALT PARTICLES PRECIPITATED IN A GOLD MATRIX. P.Gaunt and J.Silcox.

Phil. Mag. (GB), Vol. 6, 1343-5 (Nov., 1961).

Transmission electron microscope observations were made on thin foils of a gold 1.5% cobalt alloy aged at 565°C after quenching from 880°C. The observations suggest that most of the ferromagnetic cobalt precipitate particles are in the form of disks in {100} planes which are arranged in sheets, also on {100} planes. The contribution to the coercivity of the alloy from these particles due to shape anisotropy is small and the high coercivity of the alloy is probably due to some other type of anisotropy.

20604 STUDY OF PRECIPITATION PHENOMENA IN THE BINARY ALLOYS Co—Mo AND Co—W.

H.Bibring and R.Graf.

C.R.Acad. Sci. (France), Vol. 252, No. 26, 4160-2 (June 26, 1961). In French.

Discusses the structures occurring and their possible modes of transformation in the light of X-ray diffraction results. J.Thewlis

20605 STUDY ON PRECIPITATION PHENOMENA IN THIN FILMS OF SUPERSATURATED GOLD—NICKEL ALLOY.

Y.Fukano.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1195-1204 (June, 1961).

Structure changes of supersaturated gold—nickel alloy after successive agings were studied by means of electron diffraction and electron microscopy. Specimens were prepared by vacuum evaporation and subsequent quenching (Fukano and Ogawa, Abstr. 21238 of 1960). After aging at temperatures lower than 165°C, side maxima appeared beside the main spots from the matrix. The side maxima disappeared after aging at 250°-300°C, indicating that they correspond to pre-precipitations. The side maxima were interpreted by assuming a modulated structure similar to that found in Au–Pt alloy by Tiedema et al. [Acta Metallurgica (Internat.), Vol. 5, 310 (1957)]. This implies that gold–nickel alloy at the pre-precipitation stage contains a modulated structure similar to that in Au–Pt alloy. After aging at temperatures higher than 300° C, two stable phases with parallel lattices appeared. In this state, Widmanstätten structure was found in electron micrographs.

20606 EVIDENCE FOR SEVERAL FEATURES OF PRECIPITATION ON DISLOCATIONS. I.Behar.
C. R. Acad. Sci. (France), Vol. 252, No. 18, 2708-9 (May 3, 1961).
In French.

Electron metallography on cast and heat-treated nickel–chrome alloys revealed the presence of dislocations in the boundary between coherent twins. Carbide precipitates were observed to be confined to one side of the dislocations thus confirming the diffusion of interstitial atoms towards regions of hydrostatic tension associated with edge dislocations. The precipitate density was higher when boron was present due to the boron-dislocation interaction being stronger than the carbon-dislocation interaction. A.E.Kay

20607 STUDY OF MICROSEGREGATION IN THE CRYSTALLIZATION OF GERMANIUM–SILICON ALLOYS.
V.G.Fomin and O.V.Bogorodskii.
Kristallografiya (USSR), Vol. 6, No. 3, 455-8 (May-June, 1961).
In Russian.

The degree of homogeneity of polycrystalline and single-crystalline Ge–Si alloys produced by zone melting was studied by means of the physical broadening of the Debye powder pattern lines. It is shown that the magnitude of microsegregation and the character of the distribution of inhomogeneity regions in microvolumes of the alloy are functions of the Si content and the relative crystallization rate. [English translation in: Soviet Physics–Crystallography (USA), Vol. 6, No. 3, 362-5 (Nov.-Dec., 1961)].

20608 AN INVESTIGATION OF THE KINETICS OF GRAIN-GROWTH IN HIGH PURITY α-IRON.
V.I.Ivanov and K.A.Osipov.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 2, 338-41 (May 11, 1961).
In Russian.

Using an electrically heated contact furnace, with a very fast rate of heating, grain-growth in high purity iron rods was studied. Hardness, microstructure and X-ray measurements showed that cold-worked rods undergo complete recrystallization in short-time anneals. The dependence of average grain-size on the temperature of the recrystallization anneal, and the time of heating, was investigated for isothermal and non-isothermal conditions. At 890° C, the linear velocity of grain-growth is 0.35×10^{-2} cm sec^{-1}, and this value satisfies Mott's theory of local melting and the movement of groups of atoms, rather than a theory of monatomic diffusion. Following the work of Feltham, an equation is obtained relating the rate of grain-growth with its activation energy and the grain size. The activation energy for grain-growth in α-iron is found to be 25.3 kcal (g atom)$^{-1}$. [English translation in: Soviet Physics–Doklady (USA), Vol. 6, No. 5, 425-8 (Oct., 1961)].
D.J.Barber

20609 A METHOD TO REVEAL AUSTENITIC GRAIN SIZE IN HARDENABLE STEELS. M.Káldor and J.A.Verö.
Acta tech. Hungar., Vol. 34, No. 1-2, 177-84 (1961).

The method makes use of the relief formed during martensitic transformation. Two polished samples fitted together are heated in an inert atmosphere and quenched. On the polished surface the grain size of austenite is then visible without any further preparation or etching. The method is useful for ball-bearing steel. If the samples are etched, some particulars of the transformation become visible.

20610 A STUDY OF THE RECRYSTALLIZATION AND GRAIN GROWTH OF COLD ROLLED AND ANNEALED TITANIUM-10% MOLYBDENUM ALLOY.
T.H.Schofield and A.E.Bacon.
Acta metallurgica (Internat.), Vol. 9, No. 7, 653-69 (July, 1961).

The distribution of dislocations in a titanium-10% molybdenum alloy after cold deformation and annealing was studied using a decoration technique to reveal the dislocation sites. The technique depends on heating the alloy in the β phase field followed by cooling at a fairly critical rate. Specimens have been deformed at various degrees of strain by cold rolling between 4 and 80% reduction and subsequently reheated for increasing periods in the β phase field followed by cooling at the critical rate. In lightly deformed material recrystallization begins at the comparatively few points of high strain that occur at the intersection of deformation bands. At the same time sub-grains are formed in the lesser strained regions; the size of the sub-grains also seems to depend on the degree of strain and is smaller for higher strains. The new crystals grow preferentially along the deformation bands but also gradually absorb the surrounding sub-grains; islands of sub-grains may remain however even after prolonged annealing if the initial strain is slight. As growth proceeds dislocations appear to segregate into closely spaced arrays at some of the advancing boundaries. After high degrees of deformation and very short heating periods the microstructure shows a partly ordered network (mesh size $\sim 0.3\,\mu$) that probably indicates the recovery stage. Further slight heating results in the nucleation of numerous new crystals scattered at many points. The new crystals grow rapidly and consume the surrounding network and the remaining dislocations are again accommodated in arrays at the boundaries. Continued heating results in further growth and it appears that during this process some dislocations are removed by integration of the arrays at intersecting boundaries. Even after prolonged heating however some arrays remain.

20611 INVESTIGATION OF STRAIN AGEING OF QUENCH-AGED α-IRON CONTAINING NITROGEN, USING INTERNAL-FRICTION TECHNIQUE. W.S.Carswell.
Acta metallurgica (Internat.), Vol. 9, No. 7, 670-7 (July, 1961).

The strain ageing of α-iron containing nitrogen, quench-aged at various temperatures, was examined after slight strain by means of torsional pendulum damping. The changes in damping after strain can be described in three stages: an initial rise in damping, a decrease which varies as (time)$^{2/3}$, followed by a much slower decrease with time. It is suggested that these changes in damping are due to the Cottrell–Bilby mechanism of strain ageing and to the dissolution of precipitates by the dislocations. The variation in density of dislocations with strain and quench-ageing temperature may be explained by Koehler's model for the generation of dislocations.

DIFFUSION OF IRON IN IRON–COPPER ALLOYS.
See Abstr. 17557

20612 A SOLID-SOLUTION MODEL FOR INHOMOGENEOUS SYSTEMS. M.Hillert.
Acta metallurgica (Internat.), Vol. 9, No. 4, 525-35 (June, 1961).

A model allowing compositional variations in one dimension is developed from the zeroth approximation of nearest-neighbour interactions. It predicts the existence of periodically modulated structures in ordering as well as in precipitation systems. It provides a method of calculating the diffuse structure of grain and domain boundaries; it indicates the existence of an activation energy for boundary movement; and it constitutes a new approach for treating homogeneous nucleation that is free of a priori assumptions about the critical nucleus. A kinetic treatment is developed from this model, allowing calculations to be made of changes from time to time in a thermodynamically unstable system.

20613 PECULIARITIES IN THE THERMODYNAMICS OF INTERSTITIAL SOLID SOLUTIONS WITH BODY-CENTRED CUBIC LATTICE. N.S.Fastov.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 2, 344-7 (May 11, 1961).
In Russian.

A thermodynamic function is derived for the non-equilibrium free energy of a b.c.c. lattice as a function of concentration of interstitial solute, lattice deformation and the elastic constants. As examples of its use the following are worked out for polycrystals: variation of Young's modulus with strain and with concentration of solute; variation of equilibrium concentration of solute with lattice strain; variation of equilibrium concentration of solute in the neighbourhood of a spherical inclusion. [English translation in: Soviet Physics – Doklady (USA), Vol. 6, No. 5, 431-4 (Oct., 1961)].
A.F.Brown

20614 PHASE DIAGRAM FOR THE SOLID-STATE TERNARY SYSTEM Na–K–Cl–Br. Nguyen-Ba-Chanh.
J. Chim. phys. (France), Vol. 58, No. 5, 500-5 (May, 1961).
In French.

The complete diagram was determined using Debye–Scherrer X-ray methods. This diagram enables the equilibrium compositions of the A_1 and A_2 phases to be defined at all temperatures. The equimolecular reaction NaCl + KBr proceeds completely to equilibrium, whilst the inverse reaction NaBr + KCl can be arrested in a metastable state, which in a dry atmosphere, seems to be maintained indefinitely. T.E.Peacock

20615 DEFINITION OF s, THE DEGREE OF SHORT-RANGE ORDER IN A MONOPERIODIC STRUCTURE OF A BINARY SOLID SOLUTION.

M.T.Prat and R.Gay.

Bull. Soc. Franc. Mineral. Crist., Vol. 83, No. 7-9, 221-4 (April-June, 1960). In French.

Theoretical. A general expression is given for the parameter (s) which defines the order in a monoperiodic structure (a crystal viewed along the normal to one of its reticular planes) of a binary solid solution. From this the scattering due to the short-range order can be calculated. J.Iball

SHORT-RANGE-ORDER X-RAY SCATTERING IN SOLID SOLUTIONS. See Abstr. 20490

20616 THEORY OF X-RAY SCATTERING BY MULTICOMPONENT ORDERED SOLUTIONS.

M.A.Krȳvohlaz and O.O.Tȳkhonova.

Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 158-73 (1960). In Ukrainian.

Discusses X-ray scattering by partially ordered solid solutions. Formulae are derived expressing the intensity of diffuse scattering in terms of component concentration at various lattice points and of the correlation parameters, or second order derivatives of the thermodynamic potential with respect to the concentration. Crystals of the β-brass type, and crystals in which one sublattice is occupied by similar atoms and the other contains two kinds of atoms, are considered in greater detail. Formulae are presented for determination of intensity reduction factors in crystals of the NaKCl type.

20617 ATOMIC ARRANGEMENTS IN TITANIUM—MOLYBDENUM SOLID SOLUTIONS.

J.M.Dupouy and B.L.Averbach.

Acta metallurgica (Internat.), Vol. 9, No. 8, 755-63 (Aug., 1961).

The short range order and size-effect coefficients as well as the thermal and static atomic displacements have been measured in b.c.c. solid solutions of titanium—molybdenum using X-ray diffraction techniques. These solutions exhibit a strong preference for unlike near-neighbours even though a superlattice was not found. The size-effect coefficients for the first shell of atoms were negative, indicating that the molybdenum atoms were smaller than the titanium atoms in solution. Centre-to-centre distances between the different pairs of nearest neighbour atoms were calculated from the size-effect coefficients and the lattice parameters. Ti—Ti and Mo—Mo distances tended to approach the average distance in the solution at compositions between 20 and 50 at.% molybdenum. At 75% molybdenum the Mo—Mo distance was smaller than in pure molybdenum and this was taken to indicate an electron exchange in the solution.

20618 AN X-RAY DIFFRACTION METHOD FOR THE DETERMINATION OF COMPOSITION DISTRIBUTION IN INHOMOGENEOUS BINARY SOLID SOLUTIONS.

P.S.Rudman.

Acta cryst. (Internat.), Vol. 13, Pt 11, 905-9 (Nov., 1960).

The pure diffraction line profile from an inhomogeneous binary solid solution is analysed to give the composition distribution N(x) defined as the number of unit cells of composition x. The minimization of instrumental broadening is performed by Stokes's Fourier-series method and by $K\alpha_2$ elimination from high-angle reflections. The analysis is applied to Cu—Ni powders (36 at.% Cu) interdiffused at 780°C. Curves of x versus

$$\int_0^x N(x)dx \int_0^1 N(x)dx$$

which are shown to be analogous to interdiffusion concentration-penetration curves, are presented for various interdiffusion times. The average composition was determined by the X-ray analysis to ±1.5%. The results of the Stokes's analysis and the $K\alpha_2$ elimination method are compared with the conclusion that in the case considered the $K\alpha_2$ elimination method is more reliable and about ten times more rapid.

20619 THE KINETICS OF PRECIPITATION FROM SUPERSATURATED SOLID SOLUTIONS.

I.M.Lifshitz and V.V.Slyozov.

J. Phys. Chem. Solids (GB), Vol. 19, No. 1-2, 35-50 (April, 1961).

An analysis is made of the process whereby diffusion effects can cause the precipitation of grains of a second phase in a supersaturated solid solution. The kinetics of this type of grain growth are examined in detail. Some grains grow, only to be later dissolved; others increase in size and incorporate further grains that they encounter in so doing. This latter phenomenon of coalescence is discussed in a new "kinetic" approximation. Formulae are given for the asymptotic grain size distribution, for the number of grains per unit volume and for the supersaturation as a function of time. The effects of anisotropy, strain, crystalline order and the finite size of the specimen are allowed for. It is pointed out that for a material that can be said to be "supersaturated with vacancies", the discussion can be applied to the vacancies as solute "atoms" which cluster together to form internal cavities. The practical case of a real, finite crystal is here important, because the vacancies can in general also escape to the surface. A special analysis is made of this example, and the results are applied to the theory of sintering.

STRUCTURE AND ELECTRICAL PROPERTIES OF GaAs—Ga_2Se_3 SOLID SOLUTIONS. See Abstr. 19877

20620 SOLID SOLUTIONS OF In_2Te_3 IN Sb_2Te_3 AND Bi_2Te_3.

A.J.Rosenberg and A.J.Strauss.

J. Phys. Chem.Solids (GB), Vol. 19, No. 1-2, 105-16 (April, 1961).

Solid solutions of the compositions $(Sb_2Te_3)_{1-x}(In_2Te_3)_x$, where $x \lesssim 0.45$, and $(Bi_2Te_3)_{1-x}(In_2Te_3)_x$, where $x \lesssim 0.25$, were prepared in mono- or oligo-crystalline form by directional freezing. The crystals retain the hexagonal structure characteristic of Sb_2Te_3 and Bi_2Te_3, but in both cases the volume of the unit cell diminishes with increasing In concentration (measured spectrochemically). Density measurements and phase analysis prove that the mechanism of solid solution is either the direct replacement of Sb (or Bi) by In or the simultaneous replacement of Te by In and Sb (or Bi) by Te. The resistivity, Hall coefficient, and Seebeck coefficient have been measured. The In-substituted Sb_2Te_3 solutions are always p-type, but an inversion to n-type conductivity occurs in the Bi_2Te_3 alloys, particularly at high In concentrations. The magnitude of the Hall coefficient is virtually unchanged by the introduction of In. In the Bi_2Te_3 alloys, the carrier mobility is not strongly dependent on In content, but in the Sb_2Te_3 alloys it decreases sharply with increasing In concentration. The magnetic susceptibility is unchanged by the introduction of In. On the basis of these results, a model is proposed in which the nonbinding s-orbital of an In atom is transformed in the crystal into new states in the conduction band. Information is appended on the phase diagram of the In—Sb—Te ternary system.

20621 EFFECTS OF SOLID SOLUTION OF In_2Te_3 WITH $A^{ii}B^{vi}$ TELLURIDES.

J.C.Woolley and B.Ray.

J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 27-32 (Aug., 1960).

Alloys were produced for the three systems In_2Te_3—CdTe, In_2Te_3—ZnTe and In_2Te_3—HgTe and annealed to obtain equilibrium conditions. The ranges of solid solution, the variation of lattice parameter with composition and the ranges and types of ordering that occur were investigated for each system. For the systems In_2Te_3—CdTe and In_2Te_3—ZnTe, the variation of optical energy gap, E_g, with composition were determined by infrared transmission measurements, and the effects on E_g of solid solution and ordering were observed.

20622 PHENOMENOLOGICAL ASPECT OF SOME PHYSICAL PROPERTIES OF PLUTONIUM AND OF δ-PLUTONIUM-ALUMINIUM SOLID SOLUTIONS.

Y.A.Rocher and J.Friedel.

J. Phys. Chem. Solids (GB), Vol. 18, No. 2-3, 196-202 (Feb., 1961). In French.

The low temperature anomalies of electrical resistivity and thermoelectric power observed in Pu and δ Pu—Al solid solutions are interpreted in terms of an order—disorder change. A study of short-range order above the critical temperature indicates a decrease in the number of conduction electrons from 1 to 0.8 per atom as one goes from pure δ-Pu to the 10 at.% Al δ solid solution. The possible nature of the low temperature order is discussed. The anomalous expansion observed in δ-Pu and δ Pu—Al solid solutions is related to a thermally activated process. The corresponding activation energy increases linearly from 0.17 to 0.27 eV/at. as the Al atomic concentration goes from 0-5%.

20623 THE FACE-CENTRED CUBIC SOLID SOLUTIONS IN TRANSITION METAL ALLOYS OF THE FIRST LONG PERIOD. W.Hume-Rothery.

Phil. Mag. (GB), Vol. 6, 769-74 (June, 1961).

The limits of composition of the face-centred cubic solid solutions in binary alloys of the elements V, Cr, Fe, Co and Ni are discussed. The term group number (G.N.) is used to denote the position of the transition metal in the first long period (i.e. G.N. = 4 for Ti). It is shown that if the binary equilibrium diagrams are drawn in terms of the average G.N. values of the alloy, and if manganese is omitted as an abnormal element, the face-centred cubic solid solutions are stable from G.N. 10(pure Ni) to a value of about 7.7, in cases where the size-factors are favourable. The limits of the face centred cubic solid solution occurs at an approximately constant G.N. value, in very much the same way that the limits of the α-solid solutions in copper and silver alloys occur at an approximately constant electron:atom ratio. It is also shown that, when plotted in terms of average G.N. value, the liquidus and solidus curves for the γ-phases in the systems Fe—Co and Fe—Ni are almost superposed, this behaviour being analogous to that shown by the α-liquidus and solidus curves in the systems Cu—Zn and Cu—Ga.

20624 THE APPARENT METALLIC VALENCIES OF TRANSITION METALS IN SOLID SOLUTION.

B.Cockayne and G.V.Raynor.

Proc. Roy. Soc. A (GB), Vol. 261, 175-88 (April 25, 1961).

According to previous work, solution of a third metal in the close-packed hexagonal ζ-phases which occur at approximately 1.5 electrons per atom in certain binary copper alloys causes the lattice spacings to vary in such a way that the axial ratio remains constant at a constant valency electron : atom ratio. On the assumption that this remains true when the third metal is a transition metal of the VIIIth Group of the Periodic Table, the lattice spacings of solutions of manganese, iron, cobalt and nickel in the copper-germanium ζ-phase have been examined. From the observed axial ratios, the contributions of the transition metals to the conduction band of the alloy have been assessed and expressed as an effective valency value. This value, at the lower electron : atom ratios (approximately 1.39), is unity for iron, cobalt and nickel, but decreases as the electron : atom ratio rises. For manganese effective valency values at the lower electron : atom ratios vary from 1.64 to 1.42 according to manganese content; again the values decrease with increasing electron : atom ratio. The dependence of the effective valency values on transition metal content is such that, if a lattice contraction is produced by the solution of the transition metal in the binary ζ-phase (cobalt, nickel) the valency decreases as the transition metal content rises. Lattice expansion (manganese) leads to the reverse effect, while the effective valency of iron, which has little effect on the lattice spacings, is virtually independent of iron content. The results are discussed in terms of transfer of electrons between the conduction band of the alloy and the virtual bound 3d states localized on the transition metal atoms in solution.

20625 STUDY OF THE STATE OF ATOMS IN SOLID IRON—ALUMINIUM SOLUTIONS BY THE ELECTRICAL TRANSPORT METHOD.

S.D.Hertsricken, I.Ya.Dekhtyar, V.S.Mikhalenkov and E.G.Madatova.

Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 1, 79-87 (1960). In Ukrainian.

A method was developed for studying electrolytic conductivity in solid solutions, employing the displacement of inert marks by a direct current field. The laws of electrolytic conductivity were studied in iron—aluminium alloys with an aluminium content of 2.5 and 8 wt.%. It is shown that the theoretical displacement of the marks is proportional to the current density and to the time of current flow, at constant temperature. The Fe ion transference numbers at 1300°C were calculated to be 4.6×10^{-8} and 3.45×10^{-8} g ion/farad respectively, for the two alloys. It follows from the data obtained that Fe ions in iron—aluminium alloys of the investigated concentrations have a positive charge, the charge of the Fe ion in the alloy with 2.5% Al being approximately twice as great as that in the alloy with 8% aluminium.

20626 DIAMOND KNIFE ULTRA MICROTOMY OF METALS AND THE STRUCTURE OF MICROTOMED SECTIONS.

R.Phillips.

Brit. J. appl. Phys., Vol. 12, No. 10, 554-8 (Oct., 1961).

The parameters of microtome sectioning are defined, and the use of the diamond knife ultra-microtome for metallurgical studies is described. The effect of cutting stresses on the formation of sections is discussed. It is reasoned that vibration of parts of the cutting system would only be excited by the first impact of the specimen or the knife and not by the forces acting on them throughout cutting. Vibration is shown to produce smooth variations in section thickness, the thickness being constant all along any normal to the direction of cutting, and varying along the direction of cutting. Knife marks are shown to be due to variations in cutting stress associated with knife edge defects; these produce variations in the thickness and structure of the section, even when the mechanism proposed by Farrant cannot apply. Some folds and wrinkles are explained as being due to variation in cutting stress due to variations in knife edge quality. All the above defects can be avoided by a proper choice of experimental conditions, but it is shown that there is a shear stress imposed on the section during cutting which in the majority of cases permanently deforms it, producing a surface structure characteristic of the material being cut.

20627 ULTRASONIC DOUBLE REFRACTION IN WORKED METALS. P.F.Sullivan and E.P.Papadakis.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1622-4 (Nov., 1961).

In the first part the double refraction observed while measuring the attenuation of ultrasonic transverse waves in heat-treated 4150 steel was investigated. Although the data are not complete, they suggest that this double refraction phenomenon can be utilized to detect the amount of preferred orientation of the crystallites in rolled steel when this orientation is small. Calculated values of fractional velocity differences are given. In the second part the theory of ultrasonic wave propagation in polycrystalline metal is discussed, and the effect of preferential orientation of crystallites on fractional velocity changes is indicated. The use of ultrasonic double refraction data for determining the extent of preferential orientation is discussed.

20628 PURIFICATION OF MOLYBDENUM THROUGH MELTIN BY ELECTRON BOMBARDMENT.

J.L.Verot and H.Forestier.

C.R. Acad. Sci. (France), Vol. 253, No. 4, 662-3 (July 24, 1961).

In French.

99.99% pure molybdenum is obtained from 99.8% pure starting material. The rates of removal of O_2, N_2, C, Si, P, Fe, Cu and Ni at 2700°C in vacuo are given. H.Mykura

20629 CONCERNING THE DISTRIBUTION COEFFICIENT OF GOLD IN LEAD.

J.T.Jubb, E.L.Holmes and W.C.Winegard.

Canad. J. Phys., Vol. 39, No. 6, 945-7 (June, 1961).

The distribution coefficient of Au in Pb is evaluated from measurements of the onset of dentritic freezing in Au—Pb alloys, using the distribution coefficient of tin in lead as a standard. H.Mykura

20630 ON QUADRUPOLAR EFFECTS IN ALLOYS. A.Blandin and J.Friedel.

J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 170-1 (Dec., 1960).

Kohn and Vosko (Abstr. 13891 of 1960) explained the field gradients produced at the copper nuclei in copper-base alloys as due to oscillating fluctuations of the electronic density around the solute atom. The authors reached the same result independently by analysis of measurements of Bloembergen and Rowland [Acta metallurgica (USA), Vol. 1, 731 (1953)] on aluminium alloys. L.Pincherle

20631 VOID IN RESOLIDIFIED DROPS OF MOLTEN METAL. J.C.Kelly.

J. appl. Phys. (USA), Vol. 32, No. 9, 1797-8 (Sept., 1961).

Examination of drops formed in vacuo during measurements of surface tension revealed the existence of voids of appreciable size which obviously introduce errors in the value deduced if normal density is assumed. Central voids of up to 2.5 mm diameter were found in drops of nickel, niobium and tantalum with diameters of about 5 mm. Much smaller voids were obtained in tungsten and zirconium. A.E.Kay

OTHER SOLID FORMS

20632 THE FORMATION AND STRUCTURE OF GLASSES OF SIMPLE OXIDES. V.Garino-Canina.
R. Acad. Sci. (France), Vol. 252, No. 24, 3769-71 (June 12, 1961). French.

Considers qualitatively the structure of glass as a highly distorted ttice due to the presence of large numbers of Frenkel defects.

D.G.Holloway

20633 RELAXATION PHENOMENA IN GLASS. J.M.Stevels.
ed. Tijdschrift Natuurkde (Netherlands), Vol. 26, No. 12, 379-95, Dec., 1960). In Dutch.

Surveys present knowledge of relaxation phenomena in glass reep, elastic and plastic deformation, stability to thermal and ectrical shock, effect of pressure and temperature, etc.) in the ght of the atomic mechanisms involved. J.Thewlis

20634 INVESTIGATION OF LOW-TEMPERATURE ULTRASONIC ABSORPTION IN FAST-NEUTRON IRRADIATED iO$_2$ GLASS. R.E.Strakna.
Phys. Rev. (USA), Vol. 123, No. 6, 2020-6 (Sept. 15, 1961).

Ultrasonic attenuation measurements were made in normal nd fast-irradiated fused silica from 7 to 50 Mc/s and from .5° to 200° K. A broad attenuation curve, attributed to a structural elaxation with a distribution of activation energies, occurs at low temperatures. The shape of the loss curve is dependent upon the distribution of activation energies and the amplitude is proportional to the number of structural units which contribute to the relaxation process. Heavy fast-neutron irradiation produced no change in the shape of the curve while the amplitude decreased markedly. A loss associated with a specific defect, an elongated Si—O—Si bond with two equilibrium positions for the bridging oxygen atom, is consistent with the results of this study. The presence of a large number of hese defects suggests a new concept of the structure of glass. Evidence is presented to show that thermal spikes, rather than displacement collisions alone, are responsible for the fast-neutron damage in SiO$_2$.

20635 STUDIES IN THE COMPOSITION AND STRUCTURE OF GLASSES POSSESSING HIGH YOUNG'S MODULI.
II. THE COMPOSITION OF HIGH YOUNG'S MODULUS GLASSES AND THE FUNCTION OF INDIVIDUAL IONS IN THE GLASS STRUCTURE. K.L.Loewenstein.
Phys. Chem. Glasses (GB), Vol. 2, No. 3, 69-82 (June, 1961).

Glasses of high Young's modulus are obtained when the interstices of a silicate glass network are filled with ions of high field strength. Such glasses are characterized by a low content of network formers (Si, Al, B) and a high content of network-modifying ions (e.g. Mg, Ca, Ti). Compared on a cation-for-cation basis the ions most effective in raising the Young's modulus are Be, Hf, Ta, Zr, Th, Ce, Mg, Ti, Li, U. There is an approximate linear relationship between the Young's modulus of glasses and the logarithm of the field strength of the ion introduced for ions whose charge is too small or radius too large for their taking positions in the network in tetrahedral co-ordination (e.g. Ca, Zr, Ba). Ions whose radius ratio with oxygen is just above the limit for 4/6 coordination increase the Young's modulus less than would be expected from their field strengths alone. This is due to such ions (e.g. Mg, Ti, Nb, Ta) partially taking network-forming positions in tetrahedral coordination at the high configuration (structural equilibrium) temperature of glasses. The proportion of such ions entering the network is a function of their field strengths and the nature of the cation—oxygen bond.

20636 INFRA-RED ABSORPTION AND THE STRUCTURE OF GLASSES. R.V.Adams.
Phys. Chem. Glasses (GB), Vol. 2, No. 4, 101-10 (Aug., 1961).

The interpretation of infrared absorption curves is briefly reviewed and it is shown that coordination number determines the chief form of the spectra. New observations on As$_2$O$_3$ glasses are considered in detail and it is concluded that in these glasses pyramidal As$_2$O$_3$ groups exist.

A STUDY OF THE EFFECT OF γ-IRRADIATION ON PHOSPHATE GLASSES BY THE METHOD OF ELECTRON PARAMAGNETIC RESONANCE. See Abstr. 19809

20637 GLASS TRANSFORMATION OF AMORPHOUS SELENIUM. T.Sekiguti.
Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, No. 3, 281-4 (Sept., 1960).

The volume versus temperature relation of amorphous selenium was investigated in the temperature range of 0° to 40° C at various rates of temperature variation. A remarkable retardation of the volume change is observed at temperatures below 20° C.

THE SWELLING OF HIGHLY FILLED POLYMERS AND EFFECTIVE CROSSLINKING. See Abstr. 18400

THE DEFORMATION LAW FOR HIGHLY ELASTIC POLYMERS. See Abstr. 20342

THE DYNAMIC BULK AND SHEAR VISCOSITY OF HIGH POLYMERS. I. See Abstr. 20343

20638 THE EXTRACTION OF IMPURITIES FROM POLYETHYLENE IN AN ULTRASONIC FIELD.
A.A.Baram.
Akust. Zh. (USSR), Vol. 7, No. 3, 375-7 (1961). In Russian.

It is found that ultrasonic fields (717 kc/s and 22 kc/s, 7 W/cm^2) accelerate the normal process of removing impurities from polyethylene. [English translation in: Soviet Physics—Acoustics (USA)]. R.F.S.Hearmon

20639 HYPOTHESIS OF VOIDS IN SEMICRYSTALLINE POLYMERS. S.Matsuoka.
J. appl. Phys. (USA), Vol. 32, No. 11, 2334-6 (Nov., 1961).

The expression $V = xV_c + (1 - x)V_a$, for the specific volume of a semicrystalline polymer, is a highly successful approximation; here x is the degree of crystallinity, V_c is the specific volume for the crystalline regions, and V_a is the specific volume for the amorphous regions. In specimens for which x is near unity, however, this equation demands values for the parameters which are inconsistent with other experimental evaluations. It is suggested the discrepancy arises because of the presence of voids. Thus in addition to crystalline and noncrystalline regions there are regions of zero density. The average volume of such voids is not known, but their existence can be inferred from the significant, permanent density enhancement which can be brought about by pressure-induced crystallization.

20640 MOLECULAR MOTION IN DISORDERED REGIONS OF SOLID POLYEHYLENE. W.P.Slichter.
J. appl. Phys. (USA), Vol. 32, No. 11, 2339-43 (Nov., 1961).

Proton magnetic resonance studies were made to compare the molecular motions ascribable to the disordered regions of solution-grown and melt-grown specimens of solid polyethylene. Both the spin-lattice and spin—spin relaxations were studied. Restricted motion attributable to defect regions develops in solution-grown crystals as the temperature is raised, but the number of protons in motion changes reversibly with heating and cooling, provided the maximum temperature is below ~100° C. With higher temperatures the motion is greater in abundance and broader in frequency distribution. The increase is permanent despite annealing. Segmental motion attributed to molecules within the crystal is seen in solution-grown crystals in the interval 50°-100° C, but occurs to a much smaller degree in melt-grown and heat-treated samples. A model for the observed behaviour is proposed.

20641 LIGHT SCATTERING STUDY OF THE ANNEALING OF DRAWN POLYETHYLENE. M.B.Rhodes and R.S.Stein.
J. appl. Phys. (USA), Vol. 32, No. 11, 2344-52 (Nov., 1961).

Low-angle light-scattering patterns are obtained for stretched polyethylene films which are annealed both with and without the constraint of constant length. The effects of stretching temperature, annealing temperature, temperature of measurement, and degree of elongation are studied. Morphological changes in superstructure are found with parallel changes in crystal orientation.

20642 MOLECULAR STRUCTURE, COMPRESSIBILITY, SURFACE TENSION AND VISCOSITY OF CERTAIN POLYSILOXANES.* O.Z.Holyk and P.P.Cholpan.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 242-51 (1960).* In Ukrainian.

An experimental study was made of the molecular structure, density, surface tension, compressibility and viscosity of polymethyl- and polyethylsiloxanes with linear molecules. The substances were shown to possess a similar structure; the greater the intermolecular potential and the higher the critical temperature in each case, the higher the polyterms of surface tension and viscosity and the lower the polyterms of compressibility. Isoviscous substances were obtained in the polymethylsiloxane group.

GRAIN-SIZE DISTRIBUTION IN METALS AND ITS INFLUENCE ON ULTRASONIC ATTENUATION MEASUREMENTS. See Abstr. 18520

20643 RHEOLOGY OF GRANULAR MATERIAL. II. A METHOD FOR THE DETERMINATION OF THE INTERGRANULAR COHESION.

M.M.Benarie.

Brit. J. appl. Phys., Vol. 12, No. 9, 514-18 (Sept., 1961).

For previous work see Bulletin Research Council of Israel, Vol. 8F, 229 (1960). The intergranular cohesion of granular masses is investigated with an apparatus which in principle is a Couette viscometer. Rheologically, the granular mass behaves as a plastic solid, with the difference that the plastic yield point S_0 of a granular mass is a function of the pressure p which acts normally on the yielding plane. In an (S_0, p) diagram, a cohesionless mass will be represented by a straight line passing through the origin and having a limiting slope of 0.193, while a granular mass with cohesion will show a lesser slope, the departure from the limiting value being a convenient measure of the cohesion. Powders which are not free-flowing will be represented in the (S_0,p) diagram by lines, which are not necessarily straight, with an intercept on the S_0 axis. The cohesion of a few samples of sand of different granularity and that of a few other granular masses was measured.

20644 RELATION BETWEEN X-RAY LINE BROADENING OF ALUMINIUM POWDERS AND THE WARM HARDNESS OF COMPACTS PREPARED FROM THEM.

H.Romeis and P.Royen.

Naturwissenschaften (Germany), Vol. 48, No. 9, 376 (1961). In German.

The X-ray line broadening was determined for compacts prepared from Al powder and the contribution due to small particle size determined. A linear relationship was found between the Brinell hardness of the compacts at 350°C and the reciprocal of the particle size: the smaller the particle size, the greater the hardness. The significance is discussed. J.Thewlis

20645 AN APPARATUS FOR MEASUREMENT OF THE SURFACE AREA OF IRRADIATED COARSE POWDERS.

F.D.Leipziger and L.A.Altamari.

Nuclear Sci. Engng (USA), Vol. 8, No. 4, 312-14 (Oct., 1960).

An apparatus has been designed for determining the surface area of highly radioactive coarse particles. The system uses krypton as the adsorbate and a thermistor manometer to measure pressures. Measurements have been made on samples with areas as low as 50 cm^2. The design, construction, and precision of the system are discussed.

20646 SINTERING OF HIGH DENSITY URANIUM DIOXIDE BODIES.

C.Y.Ang and E.W.Burkhammer.

J. nuclear Materials (Internat.), Vol. 2, No. 2, 176-80 (June, 1960).

Compacts of at least 94% theoretical density were prepared by cold pressing at pressures up to 60 tons/in^2 and sintering at temperatures between 1500° C and 1600° C in an atmosphere of dry dissociated ammonia. Small additions of TiO_2 were found to promote densification. While the use of low compacting pressures minimized tool wear and breakage, linear shrinkage became more troublesome and values as high as 20% were encountered. The UO_2 is near its stoichiometric composition and the method appears promising as a production route. A.E.Kay

20647 FRACTOGRAPHIC STUDIES OF SINTERED URANIUM DIOXIDE.

A.Portnoff-Porneuf.

J. nuclear Materials (Internat.), Vol. 2, No. 2, 181-5 (June, 1960). In French.

Electron microscopy of fracture surfaces of UO_2 shows how the shapes and distribution of the porosities, which determine the conditions of fracture, vary with sintering temperature. Many photographs. A.F.Brown

20648 ROLE OF PRESSED DENSITY IN THE SINTERING OF FERRITE.

T.Yamaguchi.

Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, 394-401 (Dec., 1960).

Among the numerous factors responsible for the sintering performance of a ferrite element, the effects of calcination, ball-milling and compacting pressure for Mn—Zn ferrite at a fixed composition are studied. It is shown that the pressing and sintering behaviours can be interpreted successfully by means of a bulk property of the calcined powder sample to be pressed and fired, and further that the pressed density plays an important role in the controlling of shrinkage. An empirical equation is given for expressing the relation between shrinkage and pressed density. Effect of compacting pressure is interpreted in terms of conditions in powder preparation also.

20649 DIFFUSION IN POROUS MEDIA.

H.Vink.

Ark. Kemi (Sweden), Vol. 17, Paper 28, 311-17 (1961).

Flow equations for diffusion in porous media are deduced from the principles of irreversible thermodynamics. The diffusion processes are considered to take place in a multicomponent system where one of the components is fixed in space by the introduction of appropriate constraints and thus is made to form a lattice, which represents the porous medium.

20650 THERMAL CONDUCTIVITY OF POROUS MEDIA. I. UNCONSOLIDATED SANDS.

W.Woodside and J.H.Messmer.

J. appl. Phys. (USA), Vol. 32, No. 9, 1688-99 (Sept., 1961).

The problem of determining the effective thermal conductivity of a two-phase system, given the conductivities and volume fractions of the components, is examined. Equations are described which have been proposed as solutions to this problem, including those of Maxwell, de Vries, and Kunii and Smith, the weighted geometric mean equation, and an equation based on a three-element resistor model found applicable to the analogous conductivity problem. Experimental results are presented for five unconsolidated samples: three quartz sand packs, a glass bead pack, and a lead shot pack. The method of conductivity measurement using the transient line heat source (thermal conductivity probe) is described. Data are reported showing the variation of effective thermal conductivity with porosity, solid particle conductivity, saturating fluid conductivity, and the pressure of the saturating gas. From considerations based on the kinetic theory of gases, it is shown that the characteristic dimension of the pore space, with respect to heat conduction in the gas occupying this space, is smaller than the mean particle diameter by a factor of roughly 100. The thermal conductivity equations which best represent the observed data are those of de Vries, and Kunii and Smith, and a slightly modified version of the resistor model equation.

20651 THERMAL CONDUCTIVITY OF POROUS MEDIA. II. CONSOLIDATED ROCKS.

W.Woodside and J.H.Messmer

J. appl. Phys. (USA), Vol. 32, No. 9, 1699-1706 (Sept., 1961).

Measurements were made of the effective thermal conductivity of porous sandstones. The method is based on the transient heating effect resulting from use of a line heat source. Data are presented for six sandstones ranging in porosity from 3 to 59% and show the variation of thermal conductivity with porosity, the conductivity of the saturating fluid, the pressure of the gas filling the pore space, and overburden pressure. The results are compared with those previously obtained for unconsolidated sands. All samples, except one, exhibited a lower thermal conductivity when saturated with a gas at atmospheric pressure than when saturated with a liquid of the same conductivity as the gas. An explanation for this effect, in terms of the kinetic theory of gases, is advanced and substantiated by other data. Finally, the validity of certain equations for the thermal conductivity of two-phase systems is examined; the weighted geometric mean of the two constituent is found to agree well with the measured effective conductivities.

THE MARGINAL STABILITY IN POROUS INHOMOGENEOUS MEDIA. See Abstr. 18346

20652 COMPARATIVE STUDY OF THE FINE STRUCTURE OF DIFFERENT TYPES OF ARTIFICIAL CELLULOSE FIBRES.

C.Sella, D.Chaperot and J.J.Trillat.

C.R. Acad. Sci. (France), Vol. 252, No. 16, 2349-53 (April 17, 1961). In French.

Electron microphotographs illustrating the effects of ultrasonic vibrations and of treatment by acid and alkali for several types of fibre are given. R.F.Barrow

20653 AN EXPRESSION FOR ORIENTATION IN CELLULOSE FIBRES. V.D.Gupta.
Phys. Soc. Japan, Vol. 16, No. 7, 1377-80 (July, 1961).

Herman's [Recueil Trav. chim. Pays-Bas (Netherlands), Vol. 65, 7 (1946)] orientation factor can be evaluated only when the diaopic and paratropic interferences arise from planes which form an thogonal set. This is only approximately satisfied in case of th cellulose I and cellulose II. In the present communication an act expression is derived which can be evaluated from X-ray easurements, the angle between face normals of paratropic interrences and the optical constants.

THE TEMPERATURE DEPENDENCE OF THE CONDUCTIVITY F DRY CELLULOSE. See Abstr. 17632

20654 THE STRUCTURE OF ORIENTATED POLYMERIC MATERIALS.
A.Berestnev, K.Kh.Razikov, E.S.Alekseeva and V.A.Kargin.
okl. Akad. Nauk SSSR, Vol. 139, No. 5, 1093-4 (Aug. 11, 1961).
Russian.

Electron microscope photographs of thin sections of fibrous olymers, supplemented by observations in the polarization icroscope, show the presence of spherulitic and globular formaons among the fibrils. [English translation in: Soviet Physics—oklady (USA)]. R.F.S.Hearmon

20655 RELATION OF PHYSICAL BEHAVIOUR TO MOLECULAR PACKING IN CROSSLINKED RUBBER. P.Mason.
chem. Phys. (USA), Vol. 35, No. 4, 1523-4 (Oct., 1961).

Measurements were made of the specific volume at 20° C, the hermal expansion and dynamic mechanical behaviour over a emperature range including the glass—rubber transition, for amples of purified natural rubber, heated with dicumyl peroxide, n which the resulting cross-links are direct covalent bonds between arbon atoms in neighbouring chains. R.F.Barrow

Surfaces . Films . Adsorption

THE EXISTENCE OF SHOCKLEY SURFACE STATES. See Abstr. 17465

CLEAN SURFACES AND SORPTION OF GASES. See Abstr. 18493

20656 ELECTRON-MICROSCOPIC INVESTIGATION OF THE EFFECT OF THE RADIOACTIVE EMISSION OF SOLIDS ON THEIR SURFACE STRUCTURE.
V.I.Spitsȳn, L.I.Zemlyanova, I.E.Mikhailenko, V.V.Gromov and I.E.Zimakov.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 5, 1163-5 (Aug. 11, 1961).
In Russian.

During the last three years Spitsȳn and co-workers showed that the radioactive emission of solids has a substantial effect on their physico-chemical properties (sorption, solubility in water, and the kinetics of catalysis and of the heterogeneous processes of isotopic exchange). In this connection specimens of K_2SO_4, $MgSO_4$, MoO_3 and $BaSO_4$ were investigated under an electron microscope, some of the specimens having been made radioactive by means of S^{35} and Mo^{99}. The non-radioactive specimens displayed a relatively smooth surface, whereas the surface was strongly developed in radioactive specimens. A similar effect was obtained when the preparations were irradiated with 800 keV electrons. It was also observed that the radioactive solids produced on crystallization smaller crystals than the non-radioactive ones. F.Lachman

MAPPING OF THE ELECTRIC STRUCTURE OF SEMICONDUCTOR SURFACES. See Abstr. 17668

CHANGE OF SURFACE STATE OF Ge BY ELECTRON BOMBARDMENT. See Abstr. 17690

20657 CHARACTERISTICS OF THE {111} SURFACES OF THE III-V INTERMETALLIC COMPOUNDS. II. SURFACE DAMAGE. H.C.Gatos, M.C.Lavine and E.P.Warekois.
J. Electrochem. Soc. (USA), Vol. 108, No. 7, 645-9 (July, 1961).

For Pt I see Abstr. 13941 of 1960. The dissolution rate technique was applied in determining the depth of surface damage resulting from cold working (abrasion). The following III-V compounds were employed: GaAs, GaSb, InAs, and InSb. It was shown that the dissolution rates are a function of the actual surface area which in turn dependends on the amount of cold work present rather than on the original roughening of the surface. The results obtained by this method were found to be in excellent agreement with results obtained by etching (etch figures) and X-ray diffraction techniques. For the same cold-working treatment the depth of damage in InSb was found to vary for the various orientations as follows:

$$\{100\} > \mathrm{B}\{111\} > \{110\} \geq \mathrm{A}\{111\},$$

A and B designating the {111} surfaces terminating with In and Sb atoms, respectively. It was further found that for the same cold-working treatment of the A{111} or B{111} surfaces of the four compounds studied, the depth of damage varied as follows:

$$\mathrm{InSb} > \mathrm{InAs} \gtrsim \mathrm{GaSb} > \mathrm{GaAs},$$

i.e., the depth of damage decreased with increasing energy gap.

SURFACE MARTENSITE AND PLASTIC DEFORMATION. See Abstr. 20364

20658 (110) NICKEL SURFACE.
L.H.Germer, A.U.MacRae and C.D.Hartman.
J. appl. Phys. (USA), Vol. 32, No. 11, 2432-9 (Nov., 1961).

Nickel (110) surfaces, in clean and nearly clean condition, were studied by low-energy electron diffraction. When free from foreign atoms, the surface (110) plane of atoms has the normal arrangement expected for such a plane. Very slight contamination by oxygen (and perhaps other atoms) results, in some cases, in an arrangement of the topmost layer of atoms in which nickel and oxygen (or another atom) alternate along each [100] line and also along each [110] line. Study of such a surface showed that the superficial half-layer of nickel atoms is displaced toward the bulk of the crystal by about 0.10 A.

20659 STUDY OF THE TEXTURE OF THE BOUNDARY OF ETCHED AND GROUND REGIONS OF QUARTZ PLATE BY X-RAY DIFFRACTION. E.Fukushima and H.Nimura.
J. Phys. Soc. Japan, Vol. 16, No. 5, 928-36 (May, 1961).

The boundary effect, i.e. the anomalous enhancement of transmitted reflection from the boundary of the etched and ground regions of a quartz plate (Fukushima, Abstr. 8784 of 1955) was studied by an X-ray photographic method. By this method it is found that at the boundary a fairly large strain is produced and the strained layer extends to a deeper layer in the crystal than at the ground region. The influence of annealing on the boundary effect was also studied by a Bragg spectrometer. The anomalous enhancement is reduced by the annealing at the temperature of about 400° C. From the above results and some supplemental experiments on the ground surface, a model of the zone of strain at the boundary region is proposed and the mechanism of zone formation is considered.

20660 SURFACE HETEROGENEITY IN IRRADIATED SOLIDS.
D.A.Young.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 119-26 (Aug., 1960).

Experiments on the physical adsorption of krypton on unirradiated and neutron irradiated alumina were performed and analysed in terms of localized adsorption without marked lateral interaction on surfaces of varying heterogeneity. This interpretation is supported by the shape of the isotherm on unirradiated material and the dependence on coverage of the differential molar entropy of the adsorbed phase. The nature of the surface heterogeneities introduced by irradiation is discussed speculatively.

20661 SURFACE PHENOMENA DURING THE INTERACTION BETWEEN MgO(s) AND VARIOUS GASES AT ELEVATED TEMPERATURES. D.M.Speros and L.J.Schupp.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 157-66 (Aug., 1960).

The interaction between MgO(s) and various gases at elevated temperatures causes the appearance of pronounced etch patterns on the surface of the crystal. These patterns are of two distinct types with respect to their orientation relative to the crystallographic axes. In some atmospheres the etch lines are parallel to the edges of the naturally cleaved cubic MgO(s) while in other atmospheres the etch lines form a 45° angle with the edges of the crystal. In all the cases etch patterns consist of multi-atomic layer surface discontinuities that render them clearly visible to the unaided eye. Experimental and theoretical evidence is offered supporting the following postulates: (1) The pronounced surface discontinuities (i.e., multi-layer steps, kinks, pyramids, etc.) caused by etching are fundamentally due to the dependence of protective chemisorption on surface structure. (2) The orientation of the etch patterns is dependent on whether the etching agent attacks one surface ion (Mg^{2+} or O^{2-}) preferentially over the other.

20662 EXAMINATION OF TANTALUM MONOCRYSTAL TIPS BY MEANS OF A FIELD EMISSION MICROSCOPE.

L.Ernst.
Acta phys. Hungar., Vol. 13, No. 2, 169-82 (1961).

The degassing process of tantalum tips and the deformation of pure tips was examined by means of a field emission microscope, on the one hand under the influence of heating only, and on the other under the influence of both heating and an electric field. In the former case behaviour similar to that of tungsten, was observed and in the other case behaviour different from that of tungsten. The formation of twin crystals under the influence of heat was also observed.

THE FATE OF METAL-FILM CATHODES. See Abstr. 16363

EQUIPMENT FOR THE DEPOSITION AND MEASUREMENT OF THE MAGNETIC ANISOTROPY OF THIN FILMS IN A HIGH VACUUM. See Abstr. 16481

CHARACTERISTIC ENERGY LOSSES IN A 20 keV ELECTRON BEAM TRANSMITTED BY A COMPOSITE FILM. See Abstr. 17492

BREAKDOWN OF THIN FILMS. See Abstr. 17847

STRUCTURAL PROPERTIES OF THIN METAL FILMS. INFLUENCE OF SPEED OF FORMATION. See Abstr. 19939

THE DEPENDENCE OF UNIAXIAL MAGNETIC ANISOTROPY OF THIN FILMS ON THE ANGLE OF DEPOSITION. See Abstr. 20101

20663 A DETERMINATION OF THIN OXIDE FILM THICKNESS BY INTEGRATED INTENSITY MEASUREMENTS.

B.Borie and C.J.Sparks.
Acta cryst. (Internat.), Vol. 14, Pt 6, 569-70 (June, 1961).

The thicknesses of thin single-crystal oxide films are determined by integrated measurements in absolute units. The method is illustrated with measurements of Cu_2O films grown on copper single crystals. Thicknesses determined from two different Bragg maxima agree well with each other, and are reasonably consistent with the thicknesses determined from the line shapes.

20664 PRODUCTION OF THIN HYDROCARBON POLYMERIZED FILMS WITH VARYING SPECIFIC ELECTRIC CONDUCTIVITY.

H.Pagnia.
Phys. Status solidi (Germany), Vol. 1, No. 1, 90-3 (1961). In German.

The thin films were produced in a glow discharge in a benzene atmosphere at various voltages and substrate temperatures. Samples with widely varying carbon—hydrogen composition, and conductivities between 10^{-10} and 10^2/ohm cm, could be produced on the anode of the discharge vessel. A theoretical model of the films is in agreement with work on the infrared spectrum and thermal stability. The energy required for formation of a film of given mass, and the variation of conductivity during growth, are also studied.

20665 ON THE EXTRA REFLECTIONS IN ELECTRON DIFFRACTION PATTERNS FROM THIN EVAPORATED FILMS OF SOME OF THE FACE-CENTRED CUBIC METALS.

K.Bahadur and P.V.Sastry.
Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 594-5 (Oct., 1961).

Polycrystalline thin films of a number of face-centred cubic metals were prepared by evaporation on to rocksalt, followed by annealing. In a number of cases, transmission electron diffraction patterns show, in addition to the normal face-centred cubic rings, some extra rings which fit well with those which would be expected from a hexagonal close-packed form of the metals. No hexagonal close-packed rings are observed with aluminium films, and this is correlated with the absence of stacking faults on transmission electron microscope images of aluminium films.

OPTICAL PROPERTIES OF Sb, Te, AND Ti FILMS IN THE VACUUM ULTRAVIOLET. See Abstr. 19940

20666 THE STRUCTURE OF THIN FILMS OF ANTIMONY SULPHIDE.

A.M.Reshetnikov.
Kristallografiya (USSR), Vol. 4, No. 6, 926-8 (Nov.-Dec., 1959). In Russian.

Electron diffraction radial distribution curves were obtained for thin amorphous films of Sb_2S_3 grown by slow evaporation. Each antimony atom is surrounded by six sulphur atoms at 2.6 A, and the second nearest neighbours are 4 A apart. Thus the short range order is similar to that found in crystals of antimonite and in other amorphous films of Sb_2S_3. [English translation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 6, 883-5 (June, 1960)].
I.D.Brow

PREPARATION OF Bi_2O_3 FILMS. See Abstr. 19734

20667 LOGARITHMIC GROWTH OF THE CESIUM ANTIMONIDE FILMS ON ANTIMONY.

K.Miyake.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1473 (July, 1961).

When caesium vapour makes contact with an antimony film, a compound, which is thought to be CsSb, is formed. The growth rate of this film was determined experimentally by measuring the resistivity of the growing deposit.
T.C.Toye

OPTICAL INVESTIGATION OF THE STRUCTURE OF CRYOLITE EVAPORATED FILMS. See Abstr. 16100

ELECTRON-DIFFRACTION STUDY OF THIN FILMS OF CUPROUS IODIDE. See Abstr. 20536

20668 PREPARATION OF THIN FILMS OF GALLIUM ARSENIDE.

S.Martinuzzi.
C.R. Acad. Sci. (France), Vol. 253, No. 10, 1157-9 (Sept. 4, 1961). In French.

Thin films of gallium arsenide were prepared by evaporation using excess arsenic followed by re-evaporation of unassociated excess. Their optical absorption is similar to that of single-crystal material. Their low conductivity is attributed to trapped charge carriers. Hall constant measurements are unreproducible.
D.W.Goodwin

20669 MEASUREMENT OF LATTICE CONSTANT IN THIN LAYERS OF γ-IRON AND NICKEL.

H.Koritke.
Z. Naturforsch. (Germany), Vol. 16a, No. 5, 531-2 (May, 1961). In German.

Results are presented of measurements of the lattice constant made on thin layers of iron and nickel deposited from the vapour on to a monocrystalline copper surface heated to 400°C. In the case of iron a stable γ-phase layer with anomalous lattice constant is formed; with nickel diffusion appears to take place giving mixed crystal formation.
J.W.Leech

20670 CHANGE IN SUBMICROPOROSITY IN ELECTROLYTIC METAL FILMS ON HEATING AND UNDER LOAD.

B.Ya.Pines and R.I.Kuznetsova.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1475-84 (May, 1961). In Russian.

Results are reported on the small-angle scattering of X-rays by electrolytic films of Ni and Cu as affected by heat treatment and applied tension. The results are interpreted in terms of the changes produced by the treatment in the submicroscopic structure of the films. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1070-6 (Nov., 1961)].
R.F.S.Hearmon

20671 STRUCTURE OF THIN LAYERS OF SOME F.C.C. METALS DEPOSITED ON ORIENTED Ag, Pd AND Ni FILMS.

S.Shirai, Y.Fukuda and M.Nomura.
J. Phys. Soc. Japan, Vol. 16, No. 10, 1989-94 (Oct., 1961).

Ni, Cu, Pd, Al, Au, Ag and Pb were evaporated in vacuo on to oriented Ag, Pd and Ni films and the structure of the films was studied by the transmission method of electron diffraction. Some films were composed of intermetallic compounds of deposit and substrate metals; some were composed of two layers of deposit and substrate metals. In the latter case, the deposit metals grew in an overgrowth oriented in the (001) or (111) plane on a substrate metal at a temperature higher than an epitaxial temperature. The occurrence of these two kinds of oriented overgrowth depended mainly on the percentage misfits.

20672 CLEAN GLASS SUBSTRATES FOR PERMALLOY FILMS.

A.F.Fray and S.Nielsen.

Brit. J. appl. Phys., Vol. 12, No. 11, 603-8 (Nov., 1961).

Possible defects on glass surfaces and methods of detecting and reducing them are discussed. A correlation between the state of the surface and the magnetic properties of permalloy films is observed. Best results were obtained on surfaces obtained by quenching molten vacuum-melted glass.

20673 REFRACTORY STANNIC OXIDE FILM AND ITS USES.

B.P.Kryzhanovskii and A.Ia.Kuznetsov.

Pribory i Tekh. Eksper. (USSR), 1958, No. 4, 76-7 (July-Aug.). In Russian.

A description is given of a method for obtaining refractory semiconductor films of stannic oxide on ceramic and fused quartz. In distinction to films developed earlier, which were heat-resisting only to a temperature of 300-350°C, refractory films do not change their electrical properties at temperatures of 800-850°C. The high-temperature stability of the films is achieved by introducing an admixture of antimony and by subsequent high-temperature treatment. Refractory semiconductor films can be successfully used as laboratory and industrial heating elements. [English translation in: Instrum. exper. Tech. (USA), No. 4, 539-41 (July-Aug., 1958; publ. June, 1959)].

20674 THE CRYSTALLISATION OF THIN AMORPHOUS TANTALUM OXIDE FILMS HEATED IN AIR OR VACUO, AND THE STRUCTURE OF THE CRYSTALLINE OXIDE.

J.Harvey and H.Wilman.

Acta cryst. (Internat.), Vol. 14, Pt 12, 1278-81 (Dec. 10, 1961).

The effect of heat on thin films of amorphous tantalum oxide is investigated by electron diffraction. Appreciable mobility of the oxide molecules, leading to crystallization of the film, occurred only above about 700°C. The film initially crystallized to tantalum oxide with a hexagonal structure having $a = 6.17$ A and $c/a = 1.90$. Further heating led to an orthorhombic structure with $a = 6.20$, $b = 69.6$, $c = 3.90$ A.

20675 TRANSIENT KINETICS OF FORMATION OF ANODIC OXIDE FILMS ON TANTALUM IN DILUTE SULPHURIC ACID.

L.Young.

Proc. Roy Soc. A (GB), Vol. 263, 395-406 (Sept. 19, 1961).

When a high electric field is suddenly applied to a film in which the concentration of Frenkel defects is initially much lower than would be set up at this field in the steady state, the ionic current (which is supposed to be propertional to the concentration of Frenkel defects) builds up slowly at first and then more rapidly (approximately as $di/dt = ki^2$, where k increases with the field) before stabilizing at the steady-state value. This in in contradiction with the theory that Frenkel defects are produced directly by the high electric field which assists the movement of ions from lattice sites into interstitial sites. According to this theory, di/dt should be greatest at $t = 0$. The experimental result suggests that mobile ions are produced by a cascade process in which moving ions eject ions from lattice sites into interstitial sites. Experiments in which the electric field in the oxide film is suddenly changed and the ionic current is measured before the concentration of mobile ions has time to change are expected to give $f'_2(E)$, where the ionic current is determined for a given concentration of ions) by a Boltzmann factor with activation energy W_2 reduced by the field by an amount $f_2(E)$. The results were consistent with $f_2(e) = q(\alpha_2 E - \beta_2 E^2)$ where q = charge on ion, $\alpha_2 = 2{\cdot}23$ A and $\beta_2 = 0{\cdot}106$ A/(10^6 V cm^{-1}). Experiments in which fields were suddenly applied at different temperatures to films in the same initial state gave an estimate of the activation energy for ionic mobility W_2 as 1·28 ± 0·1 e V.

DIFFRACTION OF SLOW ELECTRONS AT THE SURFACE OF TUNGSTEN COVERED WITH THIN ADSORBED LAYERS OF BARIUM AND BARIUM OXIDE. See Abstr. 20701

20676 THE ADHESION OF EVAPORATED METAL FILMS ON GLASS.

P.Benjamin and C.Weaver.

Proc. Roy. Soc. A (GB), Vol. 261, 516-31 (May 23, 1961).

The adhesion of films of a large number of metals deposited by vacuum techniques on to a glass surface was examined. It was found that the affinity of the metal for oxygen plays an important role in determining the adhesion and the results appear to confirm the theory that the formation of an intermediate oxide layer at the metal/glass interface is necessary for good adhesion. There has been some doubt as to how this intermediate oxide layer is formed and the present investigation has shown that the nature and pressure of the residual atmosphere during deposition determines the extent of the formation of the oxide layer during deposition and therefore the initial adhesion of the films. However, variations in adhesion with time were observed with films of a number of metals and it would appear that if the formation of the oxide layer is not complete during deposition then diffusion of gas to the metal/glass interface can continue the formation of the oxide layer after deposition,thus accounting for the variation in adhesion with time. Since the film structure would determine the rate and extent of the diffusion of gas to the interface, it can be an important factor affecting the adhesion. Electron-microscope examination of a number of the films was made and the importance of the film structure was confirmed. Furthermore, certain anomalies such as the poor adhesion of films of the low melting point metals and aluminium can be explained on the basis of film structure.

20677 A STUDY OF THE MECHANISM OF ION PUMPING FOR THE NOBLE GASES.

G.Carter and J.H.Leck.

Proc. Roy. Soc. A (GB), Vol. 260, 303-15 (May 16, 1961).

The results of an investigation into the mechanism of sorption of the noble gases at the glass walls of a low-pressure discharge tube are presented. All the gas taken up during an ion bombardment was subsequently recovered by baking the glass up to 350°C. Some interesting information about the sorption mechanism has been obtained. The observations are all consistent with a mechanism where gas molecules are held just under the glass surface and desorb by what is effectively a single activated jump. The desorption energy was found to be spread through the range 20 to 50 kcal/mole, values not unrealistic when compared with measurements of diffusion of the noble gases through glass.

THE GAS SORPTION CHARACTERISTICS OF PENNING PUMPS AND TITANIUM FILMS. See Abstr. 18480

GAS DESORPTION AT RUBBING SURFACES IN HIGH VACUA. See Abstr. 15983

ATTAINMENT OF ULTRAHIGH VACUA, REDUCTION IN SURFACE DESORPTION, AND THE ADSORPTION OF HYDROGEN BY EVAPORATED MOLYBDENUM. See Abstr. 15974

20678 DIELECTRIC PROPERTIES OF THE ADSORBATE AT LOW SURFACE COVERAGES.

D.Fiat, M.Folman and U.Garbatski.

Proc. Roy. Soc. A (GB), Vol. 260, 409-23 (March 7, 1961).

The main purpose of the work initiated in this paper is the investigation of the dielectric properties of adsorbed vapours and gases at low surface coverages where no adsorbate—adsorbate interaction will hinder interpretation of the results. Changes in capacity were measured with an accuracy of 2×10^{-4} $\mu\mu$F by means of a high-precision capacitance meter of high stability. Ammonia adsorbed on a plate of porous Vycor glass, 1 mm thick, was studied and changes of capacity, ΔC, as a function of the amount adsorbed, V, were measured down to a surface coverage of $\theta = 0.005$. Even at low coverages, hysteresis not only in the adsorption isotherm but also in the curves of ΔC against V was found. This phenomenon confirms previous results which show the existence of different types of adsorption sites on Vycor glass differing in their energy. Time effects in ΔC on admission of NH_3 indicate a redistribution of the adsorbate molecules before final equilibrium is reached. The structure of the adsorbent in which the pores and capillaries have an average size of about 15 to 20 A allows the adsorbent-adsorbate system to be treated as a solution. With Onsager's equation, molar polarizations P_m and molar differential polarizations $P_{diff.}$ of the adsorbate as a function of V were calculated. The curves of $P_{diff.}$ against V show maxima at $\theta \cong 0.15$ at $P_{diff.}$ of about 150 — much higher than for gaseous or liquid NH_3. $P_{diff.}$ rises with temperature at small surface coverage ($\theta \cong 0.10$), whereas at higher coverages $P_{diff.}$ decreases with temperature. This is explained by restriction of rotation of the NH_3 adsorbed on high-energy sites and the increase in their freedom of rotation with temperature. Exchange of surface OH groups by OCH_3 changes the curves of $P_{diff.}$ against V in such a way as to confirm the assumption that high values of $P_{diff.}$ originate in NH_3 adsorbed on OH by hydrogen bonding. From the maximum $P_{diff.}$ the dipole moment of adsorbed NH_3 is found as 2.42 D as compared to 1.46 D for gaseous NH_3. This corresponds to a shift of the centroid of negative charge of the lone pair of 25%.

20679 MEASUREMENTS OF HEATS OF ADSORPTION OF ORGANIC VAPOURS ON ADSORBENTS OF HIGH SURFACE AREA USING A CONTINUOUS FLOW CALORIMETER.

G.H.Bell and A.J.Groszek.
Nature (GB), Vol. 191, 1184-5 (Sept. 16, 1961).

A continuous flow calorimeter, originally designed for preferential sorption studies in the liquid phase, has been successfully modified to permit the study of adsorption of organic vapours on surfaces of high specific area. Heats of adsorption are presented for various organic vapours on silica gel and activated carbon. A nitrogen flow of 50 ml/min was used as a carrier and thermistors in a Wheatstone net served as the temperature sensing system. Calibration was effected by heating a coil of nichrome wire.
F.A.Baker

20680 GENERAL THEORY OF MONOLAYER PHYSICAL ADSORPTION ON SOLIDS. W.A.Steele and M.Ross.

J. chem. Phys. (USA), Vol. 35, No. 3, 850-62 (Sept., 1961).

By suitable modifications of the general equations given previously (Abstr. 14624 of 1960), a theoretical monolayer adsorption isotherm is given which is written as a power series. The terms in the series involve integrals over the interaction energies of the adsorbed atoms with each other and with the solid. This treatment is based on a virial expansion of the density of the film in powers of the activity of the film, but differs from previous two-dimensional virial expansions in that it explicitly includes the effect of periodic variation of the solid-gas atom potential energy as the atom moves over the surface of the solid. It is shown that this general equation reduces to a sitewise model for large parallel variations in the solid-gas atom energy, and to a perfectly mobile film for small variations. However, when the potential energy for a gas atom over a simple solid is calculated as a function of the relative sizes of the gas and solid atoms, it appears that many adsorption systems may obey neither of the two limiting models. Some possible methods of dealing with adsorption systems which are neither completely localized or completely mobile are outlined and it is shown that some information about the nature of the solid-gas atom potential function may be obtained from an analysis of the experimental data for suitable systems.

A CONTRIBUTION TO THE STUDY OF THE INFLUENCE OF THE ADSORPTION OF GAS ON THE ELECTRICAL CONDUCTIVITY OF VERY THIN METALLIC FILMS. See Abstr. 17611

THE NUCLEAR PARAMAGNETIC RELAXATION TIMES OF WATER ADSORBED BY ALUMINIUM OXIDE. See Abstr. 20239

20681 MONOLAYER ADSORPTION OF HELIUM ON ARGON. M.Ross and A.Steele.

J. chem. Phys. (USA), Vol. 35, No. 3, 862-71 (Sept., 1961).

Experimental isotherms and heats of adsorption of helium on an argon surface are reported for temperatures from 10° to 20°K. The potential energy of interaction of a helium atom with an argon surface is calculated by summing the He—Ar pair interaction over the solid lattice. The experimental data are analysed in terms of a quantum mechanical modification of the theoretical treatment presented in the preceding abstract. It is shown that the adsorption properties calculated from the a priori potential function are in quantitative agreement with the experiments, in the region where a quantitative comparison can be made, and that the remainder of the data is in agreement with semiquantitative theoretical estimates. A detailed description of the probable adsorption process for the He—Ar system is deduced from the comparison between experiment and theory. It is concluded that the first half of the helium atoms comprising a monolayer on this surface are highly localized at equivalent positions over the argon lattice unit cells, and are nearly all in their quantum mechanical ground state at temperatures up to 20°K. The second half of the atoms in the monolayer is adsorbed over a different position relative to the solid lattice, and is more weakly bound than the first. Although the quantitative comparison between the theory and the experiment is somewhat limited because the quantum version of the theory is not as complete as the classical, it is concluded that the agreement between experiment and theory indicates that this approach to the problem of physical adsorption may prove useful in the analysis of data taken on other suitable systems.

20682 MULTILAYER ADSORPTION OF HELIUM ON ARGON. M.Ross and A.Steele.

J. chem. Phys. (USA), Vol. 35, No. 3, 871-82 (Sept., 1961).

Multilayer isotherms and heats are reported for helium adsorbed on an argon surface at 4.2°K. The data show that, on the uniform surface used in this work, the layer capacities and energie of the first two or three layers of adsorbed helium can be estimate directly from the heats without recourse to the isotherm data. The adsorption energies are shown to be in good agreement with theoretical estimates. Two alternate approaches to the theoretical calculation of layer capacity are presented: one of the methods involves a computation of the perturbation of the density of the bulk liquid due to the presence of the surface; the other calculation is based on a computation of the density dependence of the lateral interaction energy in a layer plus the surface interaction energy of the layer. The density of a completed layer can be estimated by equating the total energies per atom in successive layers. It is shown that the results of these calculations are in good agreement with each other, and with the experiments. The high coverage isotherm data are analysed in terms of a modified form of the Frenkel—Halsey—Hill isotherm equation, and it is shown that the parameters required to fit the experiments to this equation are consistent with other estimates. Finally, the data are fitted to the B.E.T. equation, and to several of the modified B.E.T. isotherms which have been suggested as more realistic representations of helium adsorption data. It is concluded that no B.E.T.-type model i completely successful, but that the isotherm equation proposed by Steele gives the most accurate results.

20683 AN IONIZATION METHOD OF INVESTIGATING THE KINETICS OF ADSORPTION ON SOLIDS.

Ya.P.Zingerman and V.A.Morozovskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 123-31 (Jan., 1961).
In Russian.

Describes a new method of investigating adsorption and desorption on solid surfaces by measuring the intensities of an incident atomic (molecular) beam and a beam consisting of reflected and desorbed atoms. The atoms in the two beams are partly ionized because they pass an ionization chamber. The beam intensities are deduced from the ionization currents. In this way the rates of adsorption and desorption, the heat of evaporation of adsorbed atoms, their condensation coefficient, and surface density can be found. The method also allows the determination of changes in the electronic properties of adsorbed films. The method is illustrated by a study of the adsorption of beryllium atoms on tungsten. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 1, 88-94 (July, 1961)]. A.Tybulewicz

20684 SECOND VIRIAL COEFFICIENTS OF NEON, ARGON, KRYPTON AND XENON WITH A GRAPHITIZED CARBON BLACK.

J.R.Sams, Jr., G.Constabaris and G.D.Halsey, Jr.
J. phys. Chem. (USA), Vol. 64, No. 11, 1689-96 (Nov., 1960).

Precise measurements of the adsorption of neon, argon, krypto and xenon on the highly graphitized carbon black P33 (2700°) at cove ages of less than 10% of the monolayer are reported. These data are analysed in terms of virial coefficients treatment to yield interaction energies and apparent areas. Several models for the interaction potential were investigated, but no definite choice of a model can be made on the basis of these data. Various theories for obtaining the area from the data are discussed and compared with the usual BET method for determining the area of the black. Values for the isosteric heats of adsorption at zero coverage are also discussed.

20685 KINETICS OF ADSORPTION OF IODIDE AND SULPHAT IONS ON COPPER. H.J.Arnikar and O.P.Mehta.

J. sci. industr. Res.(India), Vol. 20B, No. 5, 209-12 (May, 1961).

The time rate of adsorption on copper of I^- and SO_4^{2-} ions was studied in the low concentration region 10^{-3}M to 10^{-12}M using I^{131} and S^{35} as tracers. The adsorption is found to proceed in a stepwise manner in the concentration region 10^{-3}M to 10^{-5}M and in a continuous manner at higher dilutions. In the former case the time-rate of adsorption leading to the first plateau is distinctly higher than the subsequent stages. Alternative hypotheses based on earlie data for chemisorption of gases on solids are discussed in interpreting the subsequent slower adsorption processes as due to chemi sorption and/or due to a series of 'downpours' over 'sites' of increasing potential, following the completion of the first monoatomic layer or first few layers of relatively low potential.

20686 INTERACTION OF RARE GASES WITH SEMICONDUCTOR SURFACES. M.Green and R.Seiwatz.

J. chem. Phys. (USA), Vol. 35, No. 3, 915-21 (Sept., 1961).

The interaction of krypton with clean germanium surfaces is analysed in terms of dispersion forces, assuming a 6:12 potential.

ing the experimental value for the heat of absorption and a com- ted value for the attractive term in the 6:12 potential, the repul- ve term in the potential is calculated. The interaction energy at rious positions on the (111) crystal plane of germanium is then mputed. The method used involves recently developed techniques r the summation over a semi-infinite crystal. From this analysis effective van der Waals radius for the surface germanium atoms n be deduced, and the value (1.8 A) seems to be, from several ints of view, physically reasonable. Using an empirical combin- ion rule, it is then possible to predict heats of adsorption for her germanium—rare gas systems, viz., (Ge—Ar) 3.3 kcal/mole; e—Xe) 4.1 kcal/mole. The contribution of the induction effect the heat of adsorption at various positions on the (111) plane is lculated for a specific model, and the results show that while ere is a significant contribution, roughly 0.8 kcal/mole, the minant adsorption force is the dispersion interaction. The poss- le contribution of surface heterogeneity to the heat of adsorption discussed in terms of adsorption at a surface step. A description the method of summation over the semi-infinite crystal is dealt ith in an appendix.

20687 MECHANISM OF CHEMISORPTION, PLACE EXCHANGE, AND OXIDATION ON A (100) NICKEL JRFACE.

H.E.Farnsworth and H.H.Madden, Jr.

appl. Phys. (USA), Vol. 32, No. 10, 1933-7 (Oct., 1961).

Results obtained by low-energy electron-diffraction and photo- ectric work-function measurements indicate that the following atures result from exposure to oxygen at room temperature. itial adsorption occurs in an amorphous molecular form. Some the adsorbed molecules diffuse over the surface to lattice-defect tes where they dissociate. The resulting atoms form in a lattice ructure surrounding the defect site. With continued exposure to xygen, a place exchange between some oxygen and nickel atoms ccurs to form a single-spaced simple-square structure with a light increase in the lattice constant. This place exchange nmediately precedes, in exposure, the formation of the oxide tructure of the rock-salt type. The work function of clean (100) ickel depends on the type of anneal. $\varphi = 5.08$ eV after argon ion ombardment; $\varphi = 5.12$ eV after a small anneal; $\varphi = 5.22$ eV after more complete anneal.

20688 THE ADSORPTION OF HALOGENS ON METAL FILMS. I. ADSORPTION MEASUREMENTS AND SURFACE OTENTIALS FOR CHLORINE ON NICKEL.

J.R.Anderson.

. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 291-301 (Nov., 1960).

A technique is described for studying the adsorption of hlorine on evaporated films of nickel at chlorine pressures in he range 5×10^{-3} to 10^{-6} mm Hg, together with measurement, by he diode method, of the surface potential of the adsorbed chlorine. oth at 20°C and -122°C adsorption was very rapid up to monolayer overage. No photoactivated adsorption was found. For pressures n excess of about 10^{-4} mm Hg adsorption proceeded in excess of monolayer and at higher coverages became time dependent. here is reasonable agreement between the experimental mono- ayer capacity and that computed on the basis of dissociative adsorp- ion and each adsorbed chlorine excluding nearest-neighbour sites rom participation. At low coverages ($0 < \theta < 0{\cdot}1$) the surface otential was positive and it is suggested that this was due to dsorbed chlorines lying below the average metal surface: mechan- sms responsible for this are suggested. At higher coverages the surface potential became negative, the maximum excursion being about -1·6 V. On prolonged standing at room temperature or on aking at 300°C surface potentials moved in a positive direction and this is attributed, in the absence of desorption, to migration of nickel through the surface layer to the gas/solid interface, simultaneously producing a regenerated ability to adsorb chlorine.

20689 INVESTIGATION OF ENERGETIC INHOMOGENEITIES OF THE SURFACE IN THE SYSTEM PLATINUM—POTASSIUM.

H.Moesta.

Z. Naturforsch. (Germany), Vol. 16a, No. 3, 288-301 (March, 1961).

In German.

An experimental study, the method and technique of which are described, of desorption with rapidly rising temperature (flash-method) and of alternate ad- and de-sorption of potassium on platinum is made to determine the activation energy of the (desorption) process. The results show that with platinum, a barrier exists to the transfer of electrons from adsorbate to adsorbent and are discussed in relation to the possible role which the condition (polycrystallinity) of the surface might play in the activation mechanism.

W.Good

ADSORPTION OF GAS BY VERY THIN FILMS OF PLATINUM. See Abstr. 17612

ADSORPTION OF GAS AND THE ELECTRICAL CONDUCTIVITY OF VERY THIN FILMS OF PLATINUM. See Abstr. 17613

20690 SORPTION AND REPLACEMENT OF IONIZED NOBLE GASES AT A TUNGSTEN SURFACE.

R.B.Burtt, J.S.Colligon and J.H.Leck.

Brit. J. appl. Phys., Vol. 12, No. 8, 396-400 (Aug., 1961).

Experiments are described in which ion beams of the order of 5 µA with a low energy spread were used to bombard a tungsten surface. Sorption values for the surface are given for neon, argon and krypton and show that a maximum sorption exists at any particular bombarding ion energy. Using several simplifications a value for the depth of penetration of the ions is derived from the results and this is shown to be in reasonable agreement with values quoted by other workers. Results from a second series of experiments where ions of a second gas release the sorbed ions of the first gas are also presented.

20691 HYDROGEN BONDING INTERACTION BETWEEN ADSORBATE MOLECULES AND SURFACE HYDROXYL GROUPS ON SILICA.

M.R.Basila.

J. chem. Phys. (USA), Vol. 35, No. 4, 1151-8 (Oct., 1961).

The interactions of the surface hydroxyl groups on amorphous silica with two series of adsorbates, the methylbenzenes and the chloromethanes, were studied. A correlation is demonstrated between the frequency shifts of the surface hydroxyl stretching vibration and the ionization potential of the adsorbate. A similar correlation is found for the interaction of the hydroxyl group of a carbinol with the methylbenzene series. The importance of charge-transfer interaction in hydrogen bonding, which is indicated by these correlations, is discussed.

20692 ADSORPTION, MIGRATION AND EVAPORATION OF BARIUM ON TUNGSTEN CARBIDE.

Yu.V.Zubenko.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 528-34 (Feb., 1961).

In Russian.

Gives results of observations of barium layers on W_2C. The fall in voltage for constant field emission with increasing thickness of the Ba layer, and the current—voltage characteristics of the field emission current are determined. Photographs of the emission patterns are reproduced. The evaporation of barium occurs in three stages, and curves of the drop in field emission with time are obtained for each stage. The velocity of evaporation of barium is also determined as a function of inverse temperature. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 387-91 (1961)].

R.F.S.Hearmon

20693 ADSORPTION, MIGRATION AND EVAPORATION OF CADMIUM ON TUNGSTEN.

I.L.Sokol'skaya.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 790-5 (March, 1961).

In Russian.

The adsorption, migration and evaporation of cadmium on tungsten was investigated in a Muller electron projector and photographs of the resulting surfaces are reproduced. The work function for emission from a dense Cd layer is 4.1 ± 0.1 eV, and the heat of evaporation of Cd is 1.5 ± 0.1 eV/atom. The results are discussed in relation to the atomic sizes and to crystal orientation. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 574-9 (Sept., 1961)].

R.F.S.Hearmon

20694 ADSORPTION OF ATOMS OF ALKALINE EARTHS ON POLYCRYSTALLINE TUNGSTEN.

Ya.P.Zingerman, V.A.Ishchuk and V.A.Morozovskii.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1044-53 (April, 1961).

In Russian.

The kinetics of adsorption of Ba, Sr, Ca, Mg, and Be on polycrystalline W was studied. Heat of desorption, Q, adsorption-induced change in the work function, $\Delta\psi$, and condensation coefficient, K, were determined as well as the dependence of these parameters on the surface density, n, of the atoms adsorbed. The non-activated character (i.e. K = 1) of metals studied was established, and it was shown that, in the case of mono-atomic layers of adsorbed Ba, Sr, Ga, and Mg, Δ_ψ monotonically increases with increasing n, the work function of W being unaffected by adsorption of Be. It was found also that desorption of the metals studied from polycrystalline W is characterized by a linear decrease in Q with increasing n, this effect being attributed to heterogeneous adsorption characteristics of W. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 760-6 (Oct., 1961)]. M.H.Sloboda

MICROSTRUCTURE EXAMINATION

(By X-rays and Electron and Other Microscopes)

20695 INTENSITY OF X-RAY REFLECTIONS. V.M.Danylenko and H.Ya.Kozyrs'kyi.
Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 190-202 (1960). In Ukrainian.

The intensity of X-ray reflections from a single grain is investigated for monochromatic radiation. The width of spots on the Debye circle is calculated on the assumption that increase in width is due to the following factors: divergence of the beam, size of the grain and misorientation of coherent blocks. Formulae are given for the widths of reflections from a rotating crystal, with a moving and fixed plate.

20696 X-RAY STRUCTURE INVESTIGATION OF MICROCRYSTALS BY MEANS OF THE FINE-FOCUS X-RAY TUBE. H.Günther.
Jenaer Jahrbuch (Germany), 1960 II, 467-513. In German.

A review of principles, apparatus, and procedures. It includes a description of a fine-focus X-ray tube giving a minimum focus diameter of 50 microns; also a conical camera for single-crystal or powder photographs. A.R.Stokes

20697 X-RAY LINE BROADENING IN POLYETHYLENE FILAMENTS. K.Katayama.
J. Phys. Soc. Japan, Vol. 16, No. 3, 462-6 (March, 1961).

The precise methods of obtaining an X-ray line profile and broadening in a crystalline high polymer using an X-ray diffractometer are discussed in detail, and the causes of the X-ray line broadening in highly oriented linear polyethylene "Marlex 50" are investigated. It is found that the main causes are crystallite size effect and lattice-distortion, and the strain distribution function is approximated by the Cauchy-form $1/(1+k^2x^2)$. Therefore, the separation of two effects can be made by means of Hall's equation (Abstr. 2492 of 1950). Using 110 and 220 reflections on the equator, recrystallization of crystallite by annealing, break-up of crystallite with elongation and change in lattice-distortion are observed. The obtained values of strain (1-2%) are larger by one order of magnitude than those of cold-worked metals, and not changed so greatly by annealing and deformation, whereas crystallite size varies widely (100 to >700A).

X-RAY INVESTIGATION OF DISLOCATIONS IN Si AND Ge. See Abstr. 17537

20698 INFORMATION THEORY APPLIED TO MICROSCOPY WITH X-RAYS. G.Langner.
Forschber. Landes Nordrhein-Westfalen (Germany), No. 1001, 125 pp. (1961). In German.

This is the duplicated text of a doctoral dissertation of the Technische Hochschule, Aachen. Chapter 1 outlines the development of X-ray microscopy and of information theory, and Chapters 2 and 3 give a more detailed description of each technique. Chapters 4 and 5 discuss respectively the properties of the X-ray source and the details of the imaging process, including Fresnel diffraction. Chapter 6 investigates the different methods of X-ray microscopy in respect of their signal-to-noise ratio, contrast function and overall information-transmission capacity. Optimum values are deduced for the X-ray beam energy, object thickness, and electron beam voltage and aperture, in each of the three methods of X-ray microscopy (contact, projection and scanning). Nomograms are given to assist in evaluating these optimal conditions. Chapter 7 describes an experimental investigation of the spatial distribution of the X-ray emission produced in air by a fine electron beam, which is relevant to the discussion of the effective width of X-ray sources. There are 98 references. V.E.Cosslett

20699 A GRAINLESS INTERFERENCE FILTER PLATE FOR RECORDING X-RAY, ELECTRON AND ION IMAGES.
G.Möllenstedt and V.Rao.
Naturwissenschaften (Germany), Vol. 48, No. 10, 399-400 (1961). In German.

The device consists of a collodion film about 1500 A thick on a semitransparent evaporated silver film on a glass substrate. The object is placed directly above the plate and irradiated. Images formed by each type of radiation are reproduced. V.R.Switsur

ENERGY ANALYSIS OF ELECTRON DIFFRACTION PATTERNS See Abstr. 16421

20700 THE COMPRESSION TEXTURES OF POLYCRYSTALLIN MATERIALS OF ROCKSALT TYPE.
P.S.Dobson and H.Wilman.
Acta cryst. (Internat.), Vol. 14, Pt 12, 1275-7 (Dec. 10, 1961).

Compacted specimens prepared by compressing powders of LiF, NaF, NaCl, KCl, KBr and MgO at 75 tons/in^2 or more, are investigated by electron diffraction and X-ray diffraction. The compression textures are found to be $\langle 100\rangle$ for all these materials except MgO, which developed a $\langle 111\rangle$ preferred orientation. The $\langle 100\rangle$ texture is shown to be expected on the basis of the usual slip systems, i.e. $\{110\}$, $\langle 110\rangle$; or $\{100\}$, $\langle 110\rangle$; but the reason for the $\langle 111\rangle$ texture of the MgO is not clear.

20701 DIFFRACTION OF SLOW ELECTRONS AT THE SURFACE OF TUNGSTEN COVERED WITH THIN ADSORBED LAYERS OF BARIUM AND BARIUM OXIDE.
D.A.Gorodetskii and A.M.Kornev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1373-83 (May, 1961). In Russian.

Electron diffraction patterns were obtained from monocrystalline tungsten and from layers of barium and barium oxide deposited on it. With barium the patterns had the same nature as with plain tungsten, indicating that an ordered monlayer of barium had been deposited. With BaO deposited on cold tungsten the patterns weakened, indicating disordered structure. When however the tungsten was heated before depositing the BaO, certain order returned, indicating for example the formation of a lattice with twice the spacing of the tungsten crystal. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 997-1003 (Nov., 1961)]. A.E.I.Research Laboratory

20702 LOCAL X-RAY SPECTRAL ANALYSIS WHEN ELECTRON DIFFRACTION PATTERNS FORMED BY REFLECTION ARE OBTAINED.
L.G.Orlov, L.G.Sakvarelidze and L.M.Utevskii.
Pribory i Tekh. Eksper. (USSR), 1958, No. 4, 61-2 (July-Aug.). In Russian.

A method is described of analysing the chemical composition of very thin surface layers of a specimen and, at the same time, obtaining the phase-structure picture when electron diffraction patterns formed by reflection are obtained by means of the EM-4 electron diffraction camera. By means of a specially-designed camera, the spectrum of X-radiation which is emitted when a beam of electrons falls at glancing incidence is studied. By preparing the surface of the specimen in different ways, it is possible to carry out an analysis of certain regions, in particular grain boundary layers in steels and alloys. [English translation in: Instrum. exper. Tech. (USA), No. 4, 522-4 (July-Aug., 1958; publ. June, 1959)].

20703 CONFERENCE ON ELECTRON MICROSCOPY — NOTTINGHAM, JULY 1961. P.M.Kelly and R.Reed.
Brit. J. appl. Phys., Vol. 12, No. 11, 585-91 (Nov., 1961).

The annual conference of the Electron Microscopy Group of the Institute of Physics and the Physical Society was held in the Department of Chemistry, the University of Nottingham, from 10th to 14th July, 1961. A general account of the proceedings is given.

20704 THE DEPENDENCE OF CONTRAST IN THE ELECTRON MICROSCOPE ON THE ATOMIC NUMBER OF THE IRRADIATED SUBSTANCE. W.Lippert.
Naturwissenschaften (Germany), Vol. 48, No. 13, 475-6 (1961). In German.

Compares some recent measurements for carbon and tungsten oxide with the results of other workers and the theory of Lenz, and suggests there may in fact be some relationship between contrast and atomic number. V.R.Switsur

20705 ELECTRON MICROSCOPE CHARGE IMAGES. L.Albert and W.Jaenicke.
Naturwissenschaften (Germany), Vol. 48, No. 14, 497-8 (1961). In German.

Describes a method of recording images in the electron microscope similar to xerography. A thin layer of a semiconductor backe y a metal film records the image as a charge pattern. This is developed by a pigmented powder and fixed, yielding a diapositive ith good half-tone reproduction. The charge image is very sharp nd graininess depends upon pigment-particle size. The advantages re that the processing is fast (two minutes) and can be carried ut in a lighted room. V.R.Switsur

20706 OUT-OF-FOCUS ELECTRON MICROSCOPE IMAGES OF EDGES OF CRYSTAL LATTICES.

.M.Cowley and A.F.Moodie.

ature (GB), Vol. 189, 477-8 (Feb., 1961).

Hashimoto and Watanabe (Abstr. 4089 of 1961) have shown and iscussed the origin of extra fringes outside the edge of the image f a copper phthalocyanine crystal in a defocused electron microscope, and state that "such lines are not explicable by the theory f Cowley and Moodie". The latter now point out that this is true nly for the simplification of their theory adopted by Hashimoto nd Watanabe. Their original theory (Abstr. 5958 of 1957) treated he problem fully, and a short account is now given of its treatment in their later formulation (Abstr. 5959 of 1957; 2258 of 1958). n the image of an amplitude grating of period a, the intensity distribution in a plane defocused by an amount a^2/λ (Fourier image of rder $N = \frac{1}{2}$) shows one strong and two weak "external" fringes as n the micrographs of Hashimoto and Watanabe. V.E.Cosslett

20707 VARIATIONS OF THE METAL-CARBON EVAPORATION IMPRESSION IN ELECTROMICROSCOPIC PREPARATION. G.Hunger.

Optik (Germany), Vol. 17, No. 11, 593-601 (Nov., 1960). In German.

Dust-fine metal powders were stirred into a paste with a olution of glue, which was smeared with a paint brush on carbon ins (slightly warmed by Joule heat) or on a V-shaped tungsten wire. fter evaporation of the water the apparatus was evacuated. At the nd of the pumping-down time (45 minutes altogether), heating the arbon or wire to a dull red heat caused the glue on it to decompose nto the carbon skeleton. Somewhat stronger heating caused the metal particles to be sintered on to the carriers. After a further ive minutes pumping down, simultaneous or separate evaporations were carried out. Wires of 1 mm diameter which could be pushed orward through the lower, pierced carbon were also used in place of the metal powders stuck on with glue. As before, metal oxides or salts were used, mixed with the same volume of graphite. It is supposed that in the range of carbon evaporation, the oxides or salts were reduced to the metals and were evaporated simultaneously with the carbon on the object. Cellulose sheets were used as objects. The pictures reproduce in each case the microscopic ibrillary structure of the cellulose fibres, a matter which is not discussed in the present paper.

20708 DETERMINATION OF THE CONVERGENCE ANGLE OF ELECTRON-MICROSCOPIC STEREOSCOPIC IMAGE PAIRS USING AN ELECTRON DIFFRACTION PATTERN.

W.Kleinn.

Optik (Germany), Vol. 18, No. 5, 209-20 (May, 1961). In German.

Small crystal laminae showing a Kikuchi diagram in their diffraction images were prepared on a single object carrier diaphragm together with the object to be stereoscopically photographed. For each image of the object, the small-scale diffraction image of a crystal lamina is photographed. The angle through which the object was tilted between the two photographs was determined from the shift of the Kikuchi diagram relative to the primary ray. The procedure is to be recommended when the device on the electron microscope for object tilting does not permit a sufficiently accurate setting or measurement of the tilt angle. An accuracy of $\pm 0.03^\circ$ can be attained. As an example, the meausurement of ZnO stars was carried out. The results are in agreement with those of Strunz and Meldau [Heidelberg Beitrage zur Mineralogie and Petrographie (Germany), Vol. 2, 216-34 (1950)] but in disagreement with Fuller (Abstr. 1457 of 1944), and show that the four points of a star are in the direction of the normals to the surfaces of a regular tetrahedron.

20709 ION DAMAGE TO METAL FILMS INSIDE AN ELECTRON MICROSCOPE.

D.W.Pashley and A.E.B.Presland.

Phil. Mag. (GB), Vol. 6, 1003-12 (Aug., 1961).

The origin of small spot and loop features observed in electron micrographs of thin evaporated single-crystal gold films was investigated. It is found that the features are introduced into the specimens whilst they are being examined in the electron microscope. Conclusive evidence is given to show that they arise from bombardment by energetic negative ions emitted from the tungsten filament of the electron gun, although the ions have not been identified. The rate of ion damage can be considerably increased by coating the tungsten filament with a standard oxide emitter. The annealing characteristics of the damage were studied. Above about 300-350°C the majority of the spot features anneal out, and ion damage above about 350°C consists of the formation of small tetrahedra of stacking fault. The ion damage is assumed to be very similar in character to that produced by primary knock-ons resulting from irradiation by other particles (e.g. neutrons).

20710 DIFFRACTION CONTRAST OF ELECTRON MICROSCOPE IMAGES OF CRYSTAL LATTICE DEFECTS. II. THE DEVELOPMENT OF A DYNAMICAL THEORY.

A.Howie and M.J.Whelan.

Proc. Roy. Soc. A (GB), Vol. 263, 217-37 (Sept. 5, 1961).

For Pt. I see Abstr. 9165 of 1961. The dynamical theory of electron diffraction is developed in a form suitable for the computation of images of crystal lattice defects such as dislocations observed by transmission electron microscopy. As shown in a previous kinematical theory, the contrast arises because the waves diffracted by atoms near the defect are changed in phase as a result of the displacements of these atoms from the perfect crystal positions. The two-beam dynamical theory of diffraction in the symmetrical Laue case is derived from simple kinematical principles by methods similar to those used by Darwin in the Bragg case. Simultaneous differential equations describing the changes of incident and diffracted wave amplitudes with depth in a crystal are obtained. In a perfect crystal these equations lead to the well-known Laue solutions of the dynamical equations of electron diffraction and in a deformed crystal they reduce to the kinematical theory when the deviation from the reflecting position is large. The effects of absorption can be included phenomenologically by use of a complex atomic scattering factor (complex lattice potential). Finally it is shown that an equivalent theory may be derived directly from wave mechanics in a way which allows the effects of absorption and several diffracted beams to be included. From the formal solution of this general theory some important symmetry relations for electron microscope images of defects can be deduced.

20711 PREPARATION OF SMALL OBJECTS AS TARGETS FOR ELECTRONMICROSCOPY. E.Fuchs and R.Weyl.

Z. wiss. Mikr. (Germany), Vol. 64, No. 7, 425-8 (Oct., 1961). In German.

For the preparation of extremely small objects (~ 0.1 mm diam.) swimming in fluids it is essential to fix them to certain sites on the object carrier (object diaphragm). Two methods are described: (1) The use of suitable shapes for the object diaphragm (mask) in order to avoid the object being carried away when the diaphragm is removed from the fluid. (2) Generation of a current through the apertures of the object diaphragm, when the preparation is moved by the current into the centre of the diaphragm.

20712 PREPARATION OF AEROSOLS FOR ELECTRONMICROSCOPY. E.H.Kalmus.

Z. wiss. Mikr. (Germany), Vol. 64, No. 7, 414-18 (Oct., 1960).

A technique is described whereby fallout particles from dust clouds, commonly called aerosols, may be prepared for observation with the electron microscope. Specimens are collected by means of various types of precipitator on membrane filters made from cellulose esters. During the process of dissolving this material in acetone, the particles adhering to the filter surface are transferred to formvar-coated specimen screens for observation in the electron microscope. Losses are negligible, residual filter background is eliminated, and particles are clearly visualized for measuring or qualitative differentiation.

20713 THE [MICRO-] STRUCTURE AND HARDNESS OF ELECTRODEPOSITED CHROMIUM.

C.P.Brittain and G.C.Smith.

J. Inst. Metals (GB), Vol. 89, Pt 11, 407-16 (July, 1961).

Chromium electrodeposited at temperatures between 45° and 85°C was annealed up to 1050°C. The structure of the deposits was examined by means of optical and electron microscopy, and the hardness changes followed by microhardness measurements. The as-deposited structures are difficult to interpret, but the indications are that the grain size increases with rise in deposition temperature. A much better defined increase in grain-size occurs on annealing, the changes being particularly marked in specimens deposited at 45° and 55°C. These specimens also show the formation of a dispersed phase after short annealing times. The hardness changes correlate well with changes in grain size. It is suggested that grain size may be the main factor controlling the hardness of chromium deposits, but that the grain size may at times also be controlled by the presence of finely dispersed non-metallic material.

20714 SOME ASPECTS OF FRINGES OF MAGNESIUM OXIDE CRYSTALS OBSERVED IN THE ELECTRON MICROSCOPE. G.Dupouy and F.Perrier.
C.R. Acad. Sci. (France), Vol. 252, No. 24, 3687-92 (June 12, 1961). In French.

Characteristic fringes on magnesium oxide observed in the electron microscope are explained in relation to the faces of the crystal by means of the dynamical theory of diffraction.
V.R.Switsur

20715 MEASUREMENT OF ANOMALOUS ABSORPTION COEFFICIENTS OF ELECTRONS FOR MgO CRYSTALS. K.Kohra and H.Watanabe.
J. Phys. Soc. Japan, Vol. 16, No. 3, 580-1 (March, 1961).

The mean and anomalous absorption coefficients of electrons at 50 and 70 kV for the (200) reflection of MgO were found from measurements of intensity on bright field electron micrographs showing fringes of equal thickness. V.R.Switsur

20716 AN ELECTRON-MICROSCOPIC INVESTIGATION OF THE STRUCTURE OF SODIUM BOROSILICATE GLASS. V.E.Shelyubskii and N.M.Vaisfel'd.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 1, 100-1 (May 1, 1961). In Russian.

The two-phase structure of sodium borosilicate of composition Na_2O 7%, B_2O_3 23%, SiO_2 70% was examined by electron microscopy using an E.M. 100 at 75 kV with magnifications up to 14000 and by small-angle X-ray diffraction. The changes occurring during heating periods of up to 200 hr at constant temperatures within the range 645-755°C are described in terms of the average size of the grains, number per unit area and relative volume of the sodium borate pha [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No 422 (Oct., 1961)]. V.R.Switsu

20717 ELECTROPOLISHING TECHNIQUES FOR THE PREPARATION OF ZIRCONIUM AND ZIRCALOY-2 SPECIMENS FOR TRANSMISSION ELECTRON MICROSCOPY. J.L.Whitton.
J. sci. Instrum. (GB), Vol. 38, No. 5, 222-3 (May, 1961).

A modification is described of the technique of Boswell and Smith [Symposium on advances in electron metallography, ASTM Special Technical Publication No. 245, 31 (1958)] . Suitably thin samples are obtained in 1-3 min, depending on the thickness of the starting foil. Two figures illustrating the method and two micrographs of the results are shown. Satisfactory results were also obtained with aluminium, iron and stainless steel foils by the new technique. V.E.Cossle

20718 AN ION BOMBARDMENT DEVICE FOR MICROGRAPH SAMPLES. M.Paulus and F.Reverchon.
J. Phys. Radium (France), Vol. 22, Suppl. No. 6, 103A-107A (June, 1961). In French.

The details of design and setting up of an apparatus which allows the preparation of conducting or insulating micrographic samples by uniform ionic bombardment are given. The average surface area subjected to bombardment $\succ\sim$ 0.6 cm² being limited only by the speed of the vacuum pump. The adapation of this devic for making thinner samples of bulk materials, meant for direct examination by transmission electron microscopy, is also describ

20719 THE THEORY OF THE SCATTERING OF WAVES AND THE FOURIER TRANSFORMATION. P.Croce.
Rev. Opt. (France), Vol. 39, No. 4, 143-6 (April, 1960). In French.

Gives a brief discussion of X-ray and electron scattering whe used to study the constitution of substances and for the detection o imperfections. Scattering by solutions of large molecules is also mentioned. H.G.Jerrar

PHYSICAL CHEMISTRY

THERMOCHEMISTRY . REACTIONS

20720 THE SWITCHING CIRCUIT LOGICALLY OR FUNCTIONALLY EQUIVALENT TO A SYSTEM OF BIOCHEMICAL REACTIONS. M.Sugita.
J. Phys. Soc. Japan, Vol. 16, No. 4, 737-40 (April, 1961).

The analogy or the correspondence between the controlled or catalytic reaction and the switching circuit is given, showing that an arbitrary logical circuit can be translated into a system of controlled chemical reaction, which are catalyzed by some of the reaction products of this system. The realizability of such a chemical system is not considered but the logical possibility is discussed using several examples. Nevertheless, a way to combine the knowledge of biochemical reactions to various physiological functions can be imagined and useful suggestions to the experimental analysis of the biochemical reactions from the view-point of logical or functional analysis can be given.

20721 COMPARISON OF $CH_3\cdot$ AND $CF_3\cdot$ HYDROGEN ABSTRACTION REACTIONS.
G.O.Pritchard and G.H.Miller.
J. chem. Phys. (USA), Vol. 35, No. 3, 1135-6 (Sept., 1961).

A revaluation of recent and some past data shows that $E_m - E_x$, the difference in the respective activation energies for the hydrogen abstraction reactions of $CH_3\cdot$ and $CF_3\cdot$, is about 3 kcal per mole for all molecules, RH. W.Good

20722 STRUCTURE OF POTASSIUM FLUOROSILICATE, IN SOLUTION IN AN ALKALINE HALIDE AND IN THE PURE MELT. C.Bourlange and G.Petit.
C.R. Acad. Sci. (France), Vol. 252, No. 19, 2833-5 (May 8, 1961). In French.

The cryometric study of the solution of $K_2[SiF_6]^{2-}$ in KBr indicates the existence of a complex system of the co-equilibria

(1) $[SiF_6]^{2-} \rightleftharpoons SiF_4 + 2F^-$

and (2) $SiF_4 \rightleftharpoons Si^{4+} + 4F^-$,

with the right hand side of (1) predominant. The ultimate particles which are formed at extreme dilution have a definite existence, an the non-solvation of the silicon ions is established. In the fused me of $K_2[SiF_6]^{2-}$, the equilibrium $[SiF_6]^{2-} \rightleftharpoons SiF_4 + 2F^-$ predominates.
H.H.Hodgs

20723 OBTAINING IONICALLY PURE POLAR LIQUIDS. G.Briere.
J. Phys. Radium (France), Vol. 22, No. 8-9, 500-6 (Aug.-Sept., 196 In French.

It is possible to achieve complete de-ionization of certain pure polar liquids, as is usually done with aqueous electrolytic solutions by column operation on a mixed bed of a strong acid anion exchang and an equivalent quantity of a strongly basic cation exchanger. By applying this process to ethanol, a liquid very similar to water regards its great ionizing power, it was shown that this ionic purifi cation suits polar solvents equally well. It seems that a state clos to natural ionization was reached: confirmation in support of this is given by alcoholic electrometric measurements. After a descri tion of the apparatus used, an attempt is made to generalize the method to non-aqueous media.

20724 ANHARMONICITY IN UNIMOLECULAR REACTIONS. E.Thiele and D.J.Wilson.
J. chem. Phys. (USA), Vol. 35, No. 4, 1256-63 (Oct., 1961).

The in-line vibrations of a linear, symmetric, triatomic molecule having Morse bond-stretching potentials are studied numerically. The significance of the results for unimolecular rate theory is discussed. Harmonic and weakly anharmonic approximations appear to be inadequate.

20725 STATISTICAL COMPUTATION OF REACTION PROBABILITIES. II.

.T.Wall, L.A.Hiller, Jr and J.Mazur.

chem. Phys. (USA), Vol. 35, No. 4, 1284-9 (Oct., 1961).

For Pt I, see Abstr. 894 of 1959. With the use of a high-speed igital computer, additional numerical calculations were carried out investigate the probability of exchange attending collisions of ydrogen atoms with hydrogen molecules. The computations were ased on classical mechanics, although the potential energy was ssumed to be given by the London—Eyring—Polanyi formula. itial conditions of the particles involved were chosen by a seudorandom process, and most of the interactions proved to be of e type that failed to produce exchange. Out of more than 700 omputations, however, it was found that 6 involved exchange under rcumstances suggesting a reasonable explanation. Sample results re displayed in graphical form showing internuclear separations s functions of time. It appears from the results that molecules with ttle or no rotational energy are more likely to exchange with a olliding atom than are molecules with substantial amounts of otational energy. This can be simply explained by the fact that a on-rotating molecule can be readily constrained by an oncoming tom to a colinear configuration for which the activation energy is a inimum.

20726 "THERMAL CONDUCTIVITY" AND CHEMICAL KINETICS. R.S.Brokaw.

chem. Phys. (USA), Vol. 35, No. 5, 1569-80 (Nov., 1961).

A general expression is derived for the apparent "thermal onductivity" of reacting gas mixtures in which a single chemical eaction proceeds at a finite rate. In contrast to cases where eaction rates are either very high or very low, it is found that the hermal conductivity" depends on the geometry and scale of the ystem—hence the quotes. This expression applies to the three eometries that can be described one-dimensionally: parallel plates, oncentric cylinders, and concentric spheres. The results are mited to systems with small temperature differences, such as iermal conductivity cells, wherein reaction rate can be assumed onstant. In addition to the scale and geometry, the "thermal onductivity" is determined by three types of constants having the imensions of reciprocal length. Gas phase reaction is characterized y ϕ, which is proportional to the square root of the chemical react-on rate at equilibrium. (This is the total rate in either direction, ot the net rate, which is, of course, zero). Heterogeneous chemical eaction at the two bounding surfaces is characterized by ψ_1 and ψ_2, hile χ_1 and χ_2 account for the temperature accommodation. The ature of the "thermal conductivity" is discussed for several specific ystems. The expression is shown to approximate a numerical alculation of the effect of chemical reaction rate on stagnation oint heat transfer. Experimental thermal conductivity data for the $N_2O_4 \rightleftharpoons 2NO_2$ system are adqquately described in terms of this heory. An upper limit for the rate constant for the bimolecular issociation of N_2O_4 is estimated to be 5.3×10^9 cm^3 mole^{-1} sec^{-1} at 296°K.

MECHANISM OF DISPROPORTIONATION IN ALKYL RADICAL REACTIONS. See Abstr. 17362

20727 OBSERVATION OF FREE RADICAL KINETICS IN THE CYCLOHEXANE—OXYGEN SYSTEM.

R.L.McCarthy and A.MacLachlan.

J. chem. Phys. (USA), Vol. 35, No. 5, 1625-7 (Nov., 1961).

Pulsed 6 MeV electrons from a Lineac were used to initiate free radical reactions in the cyclohexane-oxygen system. The primary radical formed, cyclohexyl, was identified through EPR analysis of the irradiated solid sample at −100°C. In the liquid phase the cyclohexyl-peroxy radical was formed; its decay was observed spectroscopically over a period of 10 msec, and the second-order rate constants calculated. The principal reaction involving the disproportionation of two cyclohexyl-peroxy radicals requires zero ($<$ 1 kcal/mole) activation energy. The reaction rate constant is approximately 10^{-4} that for the diffusion-controlled process.

20728 OSCILLATOR MODELS IN UNIMOLECULAR REACTIONS.

M.L.Vestal and H.M.Rosenstock.

J. chem. Phys. (USA), Vol. 35, No. 6, 2008-16 (Dec., 1961).

The absolute reaction-rate theory for the unimolecular decomposition of isolated excited molecules is applied to two models. The first considers the molecule as a set of harmonic oscillators in which only a finite amount of energy may be stored in a particular degree of freedom. In the second model the spacing between adjacent levels is assumed to decrease exponentially. The first leads to a decrease in the lifetime above that calculated for the conventional harmonic oscillator model for short-lived molecules. The second produces an increase depending directly on the rate of change of the level spacing.

20729 RANDOM WALK THEORY OF ELECTRODIFFUSION.

P.C.Scholten and K.J.Mysels.

Trans Faraday Soc. (GB), Vol. 56, Pt 7, 994-1000 (July, 1960).

The increase of diffusion resulting from the interaction of a chemical reaction with an electric field is calculated by a random walk method for both d.c. and a.c. fields. Disagreements with published results are discussed.

20730 KINETICS OF THE REACTIONS OF ACTIVE NITROGEN WITH OXYGEN AND WITH NITRIC OXIDE.

M.A.A.Clyne and B.A.Thrush.

Proc. Roy. Soc. A (GB), Vol. 261, 259-73 (April 25, 1961).

The rate of decay of nitrogen atoms in a fast-flow system in the presence of oxygen was studied between 412 and 755°K. Nitrogen atom concentrations were estimated by titration with nitric oxide. The slow primary step can be represented by

$$N + O_2 = NO + O, \qquad (1)$$

while the much more rapid secondary reaction (2) removes the nitric oxide formed in reaction (1)

$$N + NO = N_2 + O. \qquad (2)$$

Reaction (1) was found to be first order in both nitrogen atom and oxygen molecule concentrations, and k_1 could be represented by the expression $k_1 = 8.3 \times 10^{12} \exp(-7100/RT)$ cm^3 mole^{-1} sec^{-1} between 412 and 755°K. Under conditions of large oxygen flow rates and at high temperatures the air afterglow continuum was observed with low but easily measurable intensity in the gaseous products of reaction of oxygen with active nitrogen. Both nitric oxide and oxygen atoms are therefore present, and not all the nitric oxide formed in reaction (1) is consumed in reaction (2). These nitric oxide concentrations were determined by measuring the intensity of the air afterglow with a photomultiplier cell, which was calibrated by observation of the increase in the air afterglow intensity when known quantities of nitric oxide were added between the first mixing point and the photomultiplier. In this way a value of $k_2 = 3.0 \times 10^{13} \exp(-200/RT)$ cm^3 mole^{-1} sec^{-1} was determined. The mean value of k_2 between 476 and 755°K was 2.5×10^{13} cm^3 mole^{-1} sec^{-1}, and was practically independent of temperature over this range, corresponding to a reaction occurring at about one sixth of the bimolecular collision frequency. It can be shown that both reactions (1) and (2) are expected to proceed through transition complexes having very similar molecular constants and vibration frequencies to those of nitrogen dioxide. However, the ratio of the frequency factors calculated on this basis, $A_1/A_2 = 1.4$, was much larger than the experimentally determined value of 0.3, and this discrepancy is outside the limits of experimental error.

20731 THE REACTION BETWEEN ACTIVE NITROGEN AND SOME CHLORINATED HYDROCARBONS AND THE OBSERVATION OF NEW BANDS DUE TO AN UNIDENTIFIED EMITTER.

G.Pannetier, L.Marsigny and P.Deschamps.

C.R. Acad. Sci. (France), Vol. 252, No. 19, 2857-9 (May 8, 1961).

In French.

The spectrum of the light emitted from reaction between active nitrogen and CCl_4, $CHCl_3$, CH_2Cl_2, CH_3Cl contains bands of N_2, CCl, CN, NH, and CH. Three new red-degraded bands at 3425.3, 3443.7 and 3475.3 A were also observed. The complete identity of the emitter is not known, but it contains C, N or H. R.W.Nicholls

20732 RELATIVE RATES OF ADDITION OF HYDROGEN ATOMS TO OLEFINES.

K.R.Jennings and R.J.Cvetanović.

J. chem. Phys. (USA), Vol. 35, No. 4, 1233-40 (Oct., 1961).

Hydrogen atoms were produced by the mercury-photosensitized decomposition of n-butane at 435 ± 5 mm pressure and at 23.5 ± 1°C. By introducing known amounts of olefine, the rate of addition of hydrogen atoms to the olefine could be measured relative to the rate of abstraction from the n-butane by observing the fall in the rate of production of hydrogen. In this way, relative rates of addition to eight olefines were obtained, and the logarithms of the relative rate constants were found to correlate reasonably well with the atom localization energies of the olefines, but not with their maximum free valence.

20733 STUDIES OF TRANSIENT SPECIES FORMED DURING CATALYTIC REACTIONS OF $CO_2 + D_2$ AND OF 1-BUTENE. C.E.Melton.

J. chem. Phys. (USA), Vol. 35, No. 5, 1751-7 (Nov., 1961).

Transient species in a catalyzed reaction were observed in the gas phase by placing the catalyst in a specially designed mass spectrometer ion source. The reaction,

$$D_2 + CO_2 \xrightarrow{Pt} D_2O + CO,$$

was studied over a pressure range 0.1-1 mm of Hg and a temperature range 50°-1100°C to demonstrate the applicability of the techniques. A free radical, of molecular formula CDO, was shown to be formed by and desorbed from the Pt catalyst during the reaction. In addition, $DCOO^-$ ions were observed suggesting the presence of an intermediate DCOOD on the catalyst. The production of the products CO and D_2O was not a monotonic function of catalyst temperature, but instead showed a maximum in the temperature range 400-500°C. The rate increased approximately as the first power of P_{CO_2} and was nearly independent of the partial pressure of D_2. The catalytic decomposition of butene-1 was studied in the same way. Free radicals produced by the catalytic decomposition of this compound are compared to those known to occur from thermal decomposition at the same temperature. In the catalytic decomposition, the radicals C_4H_7 and C_3H_5 were found to be most abundant; in contrast, CH_3 and C_3H_5 are most abundant in the thermal decomposition.

20734 MOLECULAR WEIGHT DISTRIBUTION AND REACTION SEQUENCE IN POLYMERIZATION KINETICS.

F.C.Goodrich.

J. chem. Phys. (USA), Vol. 35, No. 6, 2101-7 (Dec., 1961).

A general technique is presented for the prediction of molecular weight distributions from an assumed reaction sequence in addition polymerizations. Several problems in Szwarc polymerizations are worked as examples.

20735 THE RECOMBINATION OF ATOMS. IV. IODINE ATOM COMPLEXES. T.A.Gover and G.Porter.

Proc. Roy. Soc. A (GB), Vol. 262, 476-88 (Aug. 8, 1961).

Transient absorption spectra were detected after flash photolysis of iodine in a variety of solvents. There is some correlation between the wavelength of maximum absorption and the ionization potential of the solvent and the spectra are attributed to the charge transfer complexes between iodine atoms and the solvent which were predicted in Pt III. In the case of methyl iodide as chaperon a weak transient has also been observed in the vapour phase. The decay of the complex follows a second-order law and rate constants were measured in six solvents. Values for the extinction coefficient are derived by assuming that the reaction is diffusion controlled. Equilibrium constants of complex formation were measured in ethyl iodide and ethyl bromide.

20736 CHEMISTRY IN NUCLEAR PROCESSES. II. APPLICATION OF URANIUM FISSION TO THE SYNTHESIS OF CARRIER-FREE RUTHENOCENE (Ru^{103}).

F.Baumgärtner and P.Reichold.

Z. Naturforsch. (Germany), Vol. 16a, No. 4, 374-9 (April, 1961). In German.

The possibility of recoil-labelling with high-energy fission fragments was investigated. It was found that in a mixture of ferrocene with a uranium compound the fission of uranium produces ruthenocene and iodine ferrocene. By this method, carrier-free $Ru^{103}(C_5H_5)_2$ was produced. The relative yield of ruthenocene (Ru^{103}) was measured with different ratios of uranium to ferrocene, ranging from 0.013 to 0.325. At a ratio of 0.013 about 60% of the total Ru^{103} is bound in form of ruthenocene. The yield decreases to 45% at a ratio of 0.325. In order to explain these high yields it is suggested that the labelling is performed not only by the primary fission Ru^{103}, but especially by secondary Ru^{103} formed by β-decay.

ORGANIC SEMICONDUCTORS: AROMATIC HYDROCARBON POSITIVE IONS IN SOLIDS. See Abstr. 19866

20737 FLAME PROPAGATION IN FREE-RADICAL-CONTAINING SOLIDS AT LOW TEMPERATURES.

A.L.Berlad.

J. chem. Phys. (USA), Vol. 35, No. 4, 1180-4 (Oct., 1961).

A nonadiabatic theory of flames is formulated which describes the features of flame propagation in free radical containing cryogenic solids. This "cryogenic flame" theory is an extension of nonadiabatic flame theory associated with gaseous flames. The general features of cryogenic flames prescribed by the theory include: the characteristic propagation velocity of the reaction wave, the spatial structure of the composition and temperature fields, and the extinction limits associated with flame existence-nonexistence. Application of the formulation is illustrated for the case of flame propagation in N-atom-containing solid N_2.

20738 ASYMMETRY OF CYCLOTRON RESONANCE LINES IN THE REACTION ZONES OF LOW-PRESSURE ACETYLENE AND CYANOGEN FLAMES.

E.M.Bulewicz and P.J.Padley.

J. chem. Phys. (USA), Vol. 35, No. 5, 1590-3 (Nov., 1961).

A marked asymmetry and shift of line maximum (at 17 000 gauss by more than 100 gauss is reported for cyclotron resonance lines obtained in or very close to the reaction zones of low-pressure flames containing high concentrations of free electrons. The effect is interpreted in terms of the variation of the real part of the refractive index of the flame plasma, at microwave frequencies, in the neighbourhood of the absorption line. The electron concentratio gradients in the vicinity of the reaction zone then have the effect of refracting the microwaves traversing the finite thickness of the plasma towards or away from the microwave receiver.

20739 GASEOUS DETONATIONS. XIII. ROTATIONAL AND VIBRATIONAL DISTRIBUTIONS OF OH RADICALS.

G.B.Kistiakowsky and R.K.Lyon.

J. chem. Phys. (USA), Vol. 35, No. 3, 995-99 (Sept., 1961).

In an earlier paper (Abstr. 5629 of 1959) in this series, some observations of the rotational temperature of OH radicals in the reaction zone of gaseous detonations were reported and interpreted as meaning that abnormal rotational excitation is produced by extremely fast chemical reactions. In the present study new experiments were made on detonations of $C_2H_2 + 2\frac{1}{2}O_2$ and $CO + H_2 + O_2$ mixtures. An improved method of data reduction was developed an applied to both the new and the previously reported experiments. I is concluded that in all reported experiments the vibrational and rotational distributions of OH remain the same within experimental errors from the front of the wave to beyond the C-J plane. This is tentatively attributed to the turbulent gas flow behind the detonation front which restricts the usefulness of the present method, rather than to abnormal distributions in the reaction zone caused by fast chemical reactions.

20740 GASEOUS DETONATIONS. XV. EXPANSION WAVES I GASEOUS DETONATIONS. H.Miyama and P.Kydd.

J. chem. Phys. (USA), Vol. 34, No. 6, 2038-45 (June, 1961).

For Pt XIV, see Abstr. 12677 of 1961. The ultraviolet absorption spectrum of OH and the visible light emission profile in the rarefaction wave following a detonation in $C_2H_2 + H_2 + 2O_2$ were measured. Analysis of the absorption spectrum at an initial pressure of 60 mm Hg gives an average rotational temperature of 3164°K during the first 310 μsec after the detonation wave front. The gas temperature calculated by using detonation theory and necessary thermodynamic data is 392°K higher than the experimental rotation temperature. The difference is very close to the difference of 350° which has been predicted by James theoretically. The emission pro files demonstrated the presence of double waves at initial pressure higher than 90 mm and the appearance of these waves coincides wit an increase in detonation velocity to that calculated using a "frozen" sound velocity. In expansion waves produced by bursting a thin diaphragm with the detonation wave, the emission intensity was found t be far higher than predicted and the velocity of the expanding gas and the shock wave ahead of it to be somewhat lower than expected.

20741 CONTRIBUTION TO THE STUDY OF CHEMISORPTION OF OXYGEN ON ZINC OXIDE. J.M.Thuillier.

Ann. Phys. (France), Vol. 5, No. 7-8, 865-913 (July-Aug., 1960). In French.

Chemisorption was studied as a function of the modification it causes in the electric properties of the specimen. Measurements of conductance and of the p.d of contact determine the density of chemisorbed atoms and the barrier height, respectively. The results obtained agree well with theory, especially with respec to the laws of kinetic processes. F.Lachma

20742 LOW-TEMPERATURE CHEMISORPTION. III. STUDIES IN THE FIELD EMISSION MICROSCOPE.

Ehrlich and F.G.Hudda.
chem. Phys. (USA), Vol. 35, No. 4, 1421-39 (Oct., 1961).

For Pt II see Abstr. 4101 of 1961. The dependence of adsorption
on surface structure was examined with the field emission micro-
ope. Nitrogen adatoms are found on all the planes of tungsten
cessible to observation. Their rate of diffusion is fastest over
regions around the 111 pole; the barrier to migration over this
ea is only 20 kcal mole^{-1}, compared to 35 kcal mole^{-1} for
ffusion over the sharply stepped region surrounding the 100 pole.
strong structural effect is observed for the weakly bound α state
nitrogen, unstable at $T > 400^0$K. This state is concentrated on
d around the (111). By contrast, nitrogen molecules held at 79°K
the γ state are distributed without pronounced specificity for
rface structure. However, the absence of diffusion in both these
ates suggests that the nitrogen is held at isolated, discrete sites.
e γ state on tungsten somewhat resembles nitrogen adsorbed on
ckel; for this system chemisorption is lacking at room tempera-
re, but at 79°K molecules are bound with an energy of at least
5 kcal mole^{-1}. At an even lower temperature, $T \sim 20^0$K, an
ditional binding state, consisting of nitrogen physically adsorbed
top of the chemisorbed layer, is observed on tungsten. Diffusion
t of this state occurs at $T \sim 40^0$K with the formation of a sharp
rder, indicating immediate chemisorption of material spilling over
e chemisorbed layer. For the adsorption of carbon monoxide on
ngsten no structural specificity appears in the field emission
icroscope. In addition to the primary chemisorbed state, the
esence of weakly bound carbon monoxide is confirmed and it is
own that for neither state does dissociation occur. Both carbon
onoxide and nitrogen lower the rate of electon emission from an
itially clean tungsten suface. CO raises the work function by
5 eV at $T \sim 300^0$K. In the γ state nitrogen also causes an initial
ork function increase of 0.1 eV. Nitrogen adatoms, however, are
und to lower the work function, in contrast with the results
tained for other dissociating gases, as well as with previous work
nction measurements on nitrogen itself.

20743 RECOMBINATION OF ATOMIC OXYGEN ON SURFACES.

D.S.Hacker, S.A.Marshall and M.Steinberg.
chem. Phys. (USA), Vol. 35, No. 5, 1788-92 (Nov., 1961).

Catalytic surface recombination of atomic oxygen was studied
a flow system by paramagnetic resonance absorption and a
mparison is made with platinum wire detectors for the same
nditions of flow. Recombination of oxygen atoms on a fuzed quartz
rface is found to follow first-order kinetics with a surface re-
mbination efficiency of 4.0×10^{-5} per collision. Recombination
platinum wire detectors held at 200° and at 850°C is also found
be first order in oxygen atoms with surface recombination
ficiencies of (0.01 ± 0.002) and (0.1 ± 0.02) per collision, respect-
ely. Efficiencies for platinum are determined from the surface
ecombination heating and the strength of the oxygen-atom magnetic
esonance. The atom-decay rate down the flow tube is found to be
rst order in oxygen atom with a dependence on the total pressure
at suggests the homogeneous formation and subsequent reaction of
zone. The observed rates are consistent with the following scheme:

$$O + O.S \xrightarrow{k_1} O_2 + S \qquad (S = \text{surface}).$$

$$O + O_2 + M \xrightarrow{k_2} O_3 + M \qquad (M = \text{third body}).$$

$$O + O_3 \xrightarrow{k_3} 2\,O_2.$$

he three-body rate constant k_2 is found to have a value of
.5 × 10^{14} cc^2 mole^{-2} sec^{-1}.

ELECTROCHEMISTRY

INVESTIGATION OF CHANGES IN CHARGE-CARRIER DIFFUSION LENGTH AND ELECTRODE POTENTIAL OF GERMANIUM UNDER ELECTROLYTIC TREATMENT. See Abstr. 17677

20744 A CONTRIBUTION TO THE STUDY OF ELECTRODE POTENTIAL IN SILICON. G.Feuillade.

C.R. Acad. Sci. (France), Vol. 252, No. 25, 3958-60 (June 19, 1961). In French.

Details are given of the effects of pH, stirring, time, gaseous oxygen, F^-, $SiO_2-SiF_6^{2-}$ and $Fe^{2+}-Fe^{3+}$ on th electrode potential of silicon in solution. Results are interpreted in terms of a previous theory (Abstr. 7915 of 1961). D.W.Goodwin

20745 SATURATION CURRENTS IN SILICON ELECTRODES. G.Greger.

Z. Naturforsch. (Germany), Vol. 16a, No. 3, 284-8 (March, 1961). In German.

The current-voltage characteristic of cathodically polarized p-Si electrodes depends upon the electrolyte and was found to vary between an exponential and a linear relationship. No pronounced saturation current was observed with NaOH as electrolyte. The dependence upon temperature was investigated for the linear case. It appeared that the carriers came from centres corresponding to low terms. Evidence for chemical polarization, probably by the formation of SiH, was obtained. During anodic polarization oxidation took place. At high concentrations of alkali the dissolution of the oxide layer prevented the formation of oxide films. With n-Si electrodes saturation currents are only possible for anodic polarization. R.Schnurmann

20746 KINETICS OF CATHODIC PROCESSES ON SEMICONDUCTOR ELECTRODES WITH THE PARTICIPATION OF VALENCE-BAND ELECTRONS.

R.M.Lazorenko-Manevich and S.O.Izidinov.
Dokl. Akad. Nauk SSSR, Vol. 140, No. 1, 172-5 (Sept. 1, 1961).
In Russian.

An analysis of the effect of valence electron participation on the form of transport equations in the case of semiconductor electrodes is based on the work of M.Green [Modern Aspects of Electrochemistry, Vol. 2, (1959)]. The results for the case when only valence electrons participate in cathodic processes agree with those obtained by Vdovin, Grafov and Myamlin (Abstr. 6101 of 1960), who used a different method of approach. Equations are also obtained for the case of simultaneous participation of both valence and conduction electrons; these equations are illustrated on the example of polarization of Si in alkaline solutions. F.Lachman

ION SIZE EFFECT AND MECHANISM OF ELECTROLYTIC RECTIFICATION. See Abstr. 18749

20747 INVESTIGATION OF THE MECHANISM OF RECTIFICATION IN AN OXIDIZED ZIRCONIUM ELECTRODE.

N.G.Bardina and P.D.Lukovtsev.
Dokl. Akad. Nauk SSSR, Vol. 140, No. 5, 1102-5 (Oct. 11, 1961).
In Russian.

To determine the component of the total electrode—solution potential drop, relating to the oxide—solution boundary, the dependence on the redox potential of the resistance R and capacity C of an oxidized Zr electrode was studied. It was found that, as the redox potential assumed less positive values, the capacity increased and the resistance decreased; at the same time corresponding minima and maxima were found for points for which the concentrations of the oxidizing and reducing agent (ferri- and ferrocyanide, or ferric and ferrous ions) in the solution were identical. The results obtained appear to bear out the idea that the distribution of carriers in the oxide film is irregular and that the oxide—solution boundary has a substantial effect on the electrophysical properties of the film; it also appears that the rectifying effect of the oxide film is related to the increase of concentration of the current carriers in the film layer adjacent to the solution, when the potential becomes more negative. F.Lachman

20748 ON THE POLYELECTROLYTE—SIMPLE-ELECTROLYTE INTERACTION PARAMETER. N.Ise.

J. chem. Phys. (USA), Vol. 35, No. 3, 1145 (Sept., 1961).

A formula for this is given, based on simplifying assumptions and on previously discussed equations. [Journal of Polymer Science

(USA), Vol. 39, 389 (1959)]. From it the radius of the macro-ion (assumed spherical) is evaluated at different self-concentrations. It is found to be in reasonable agreement with the radius as evaluated from Einstein's viscosity relation. W.Good

20749 INTERFACIAL SOLUTIONS OF THE POISSON—BOLTZMANN EQUATION. F.H.Stillinger, Jr.
J. chem. Phys. (USA), Vol. 35, No. 5, 1584-9 (Nov., 1961).

The linearized Poisson—Boltzmann equation is considered for boundary conditions corresponding to a fixed point-charge ion near the planar boundary between an electrolytic solution and a dielectric substrate. Use of the Fourier expansion for this fixed charge density allows the mean potential to be synthesized in the form of a simple quadrature. Subsequently, it is possible to compute the reversible work necessary to displace the ion atmosphere surrounding this charge into one hemisphere as the charge is brought up to the interface from the interior of the electrolyte phase. Implications for ionic adsorption processes are discussed. The result of a similar analysis for the mean potential surrounding a point dipole oriented normally to the boundary is also presented.

20750 INTERACTION BETWEEN POLYIONS AND LOW MOLECULAR IONS. N.Imai.
J. Phys. Soc. Japan, Vol. 16, No. 4, 746-60 (April, 1961).

The characteristic nature of ion-binding of highly charged polyions is investigated mainly on the basis of the Poisson—Boltzmann (P.B.) equation and partly through the conductance experiment. In general, the ion-binding can be classified into two types, the Ψ-binding and the P-binding. The former is due to the electrostatic field around the polyions, while the latter is due to the short-range interaction between ionized groups of polyions and salt-ions. Through the theoretical analysis of non-linear property of the P.B. equation, a strong Ψ-binding of counterions which greatly depresses the polyion-charge within a thin ion-condensation phase around the polyion is found for every shape of polyion. By exactly solving the two-dimensional P.B. equation, the ion-distribution around many rod-like polyions and the two-step ion-condensation phenomenon are obtained at the first step, counterions are condensed in the neighbourhood of the assembly of polyions, and at the second step, a similar condensation phenomenon occurs around each of the polyions. The alteration of spatial arrangement of polyions causes a large change in the activity coefficient of small ions. Through the conductance measurement, the strong P-binding of divalent cations to polyions is found. Generally, the P-binding is very much strengthened by the effect of Ψ-binding.

20751 ELECTRODIALYSIS UNIT FOR FISSION PRODUCT SEPARATION. G.J.Bub and W.H.Webb.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 857, (July, 1961).

The radioactive components of 1N HF (or $NH_4F.HF$) solution containing Zr^{95}, Cs^{137}, and Ce^{144} were separated in a 3-cell electrodialyser by applying 125 mA cm^{-2} d.c. for 2 hr; Zr^{95} migrated to the anode cell, Cs^{137} to the cathode cell, and Ce^{144} remained in the feed cell as a radiocolloid. Nearly 100% separation was achieved. A.Avraam

THE DISTANCE OF APPROACH OF IONS IN WATER SOLUTION FROM THE NUCLEAR MAGNETIC RESONANCE LINE WIDTHS. See Abstr. 18398

ELECTRODIFFUSION TREATED AS A RANDOM WALK PROBLEM. See Abstr. 18324

ISOTOPE ENRICHMENT OF Mg, Ca, Sr AND Ba BY ION MIGRATION IN MOLTEN HALIDES. See Abstr. 19613

MEASUREMENT OF RESIDUAL STRESSES IN ELECTROLYTIC COATINGS. See Abstr. 20323

FORMATION OF ANODIC OXIDE FILMS ON TANTALUM IN DILUTE SULPHURIC ACID. See Abstr. 20675

EXCHANGE RATE OF IONS CONTAINING BROMINE AND IODINE IN WATER SOLUTION FROM THE NUCLEAR MAGNETIC RESONANCE LINE WIDTHS. See Abstr. 18399

SAWTOOTH [SOUND] WAVES IN ELECTROLYTES. See Abstr. 18517

PHOTOCHEMISTRY RADIATION CHEMISTRY

20752 IRREVERSIBLE THERMODYNAMICS OF SYSTEMS CONTAINING RADIATION. APPLICATION TO PHOTOCHEMICAL REACTIONS. R.G.Mortimer and R.M.Mazo.
J. chem. Phys. (USA), Vol. 35, No. 3, 1013-18 (Sept., 1961).

The general theory of the irreversible thermodynamics of chemically reacting systems interacting with radiation is developed. From this, a limit to the efficiency of photochemical processes is derived, and this is compared with approximate experimental efficiencies of published researches. The computed efficiencies are appreciably lower than the theoretical limit; reasons for this are discussed.

20753 MECHANISM OF THE MERCURY PHOTOSENSITIZED DECOMPOSITION OF n-BUTANE.
R.J.Cvetanović, W.E.Falconer and K.R.Jennings.
J. chem. Phys. (USA), Vol. 35, No. 4, 1235-33 (Oct., 1961).

For previous work, see Abstr. 8352 of 1955. The results of further studies of the mercury photosensitized reactions at room temperature of n-butane and of its mixtures with nitrous oxide are reported. The importance of a self-scavenging process responsible for low quantum yields of hydrogen at finite conversions was demonstrated by carrying out experiments at low conversions closely approaching initial conditions. The initial quantum yield of hydrogen was determined relative to that of nitrogen from the mercury photosensitized decomposition of nitrous oxide. The mechansim of the self-scavenging process is discussed.

20754 PRIMARY PROCESSES IN Hg($^3P_1$) PHOTOSENSITIZED REACTION OF CYCLOPROPANES.
D.W.Setser, B.S.Rabinovitch and E.G.Spittler.
J. chem. Phys. (USA), Vol. 35, No. 5, 1840-4 (Nov., 1961).

Cyclopropane-d_2 and 1, 2-dimethylcyclopropane were studied at 25°C and above. Cis—trans isomerization is apparently of general occurrence in Hg($^3P_1$) photosensitization of substituted cyclopropanes. The most important primary process in the quenching of Hg atoms by cyclopropane-d_2 seems to be the formatio of triplet cyclopropane diradicals through which isomerization proceeds. Some exchange occurs at higher temperature. The Hg($^3P_1$) photosensitized polymerization and exchange of D_2 mixtures with cyclopropane also proceeds readily at elevated temperature (135°C).

20755 INFRARED SPECTROSCOPIC STUDY OF THE PHOTOLYSIS OF METHYL AZIDE AND METHYL-d_3 AZIDE IN SOLID ARGON AND CARBON DIOXIDE. D.E.Milligan.
J. chem. Phys. (USA), Vol. 35, No. 4, 1491-7 (Oct., 1961).

Experiments were carried out on the photolysis of methyl azide and methyl-d_3 azide at high dilution in solid argon (4.2°K) and carbon dioxide (~50°K). Photolysis of these species in argon and carbon dioxide matrices results in the appearance of a number of new spectral features in the 3300-600 cm^{-1} region. The spectroscopic data for the photolysis products appear to be consistent with the identification of these species as methyleneimine ($CH_2=NH$) and methyleneimine-d_3 ($CD_2=ND$).

20756 PHOTOCHEMICAL DECOMPOSITION OF NITRYL CHLORIDE. A.S.Dohner and D.J.Wilson.
J. chem. Phys. (USA), Vol. 35, No. 4, 1510-11 (Oct., 1961).

Experiments are described which show that chlorine atoms react rapidly with nitryl chloride and so provide additional support for Schumacher and Springer's mechanism for the decomposition of nitryl chloride:

$$NO_2Cl \rightarrow NO_2 + Cl \ (k_1),$$

$$NO_2Cl + Cl \rightarrow NO_2 + Cl_2 \ (k_2),$$

in which the velocity coefficient k_2 is much larger than k_1.
H.H.Hodgson

20757 REACTIONS OF METHYL WITH ISOPROPYL RADICALS. C.A.Heller.
J. chem. Phys. (USA), Vol. 35, No. 5, 1711-13 (Nov., 1961).

The photolysis of methyl isopropyl ketone was used to study e reaction of methyl and isopropyl radicals at 100° in the gas ase. The disproportionation/combination ratio is 0.17 ± 0.03. e ratio, $(\text{isobutane})^2/(\text{ethane} \times \text{hexane})$ is 3.5 ± 0.33. Deuterated tone was used to permit correction for abstraction reactions.

20758 KINETICS OF THE PHOTOLYSIS OF SODIUM AZIDE.

J.G.Dodd.

chem. Phys. (USA), Vol. 35, No. 5, 1815-19 (Nov., 1961).

The evolution of N_2 from solid NaN_3 during photolysis is own to result from active sites located as deep as a few hundred ttice constants within the crystallites. These active sites diffuse the free surface to produce N_2, exhibiting a diffusion constant 10^{-15} cm^2/sec. The absorption constant of NaN_3 for 2537 A adiation is measured to be about 1.8×10^5/cm, and quantum fficiences for photolysis are determined to be 0.040 for photolysis the surface layer and 0.12 for equilibrium nitrogen evolution om a partially decomposed mass. The reaction is shown to be rst order with respect to light intensity. A mechanism for photo-sis is suggested based upon Thomas and Tompkins' exciton ecomposition scheme.

20759 FIXATION OF MOLECULAR NITROGEN UNDER THE ACTION OF ULTRASONIC WAVES WITH THE ORMATION OF BIOLOGICALLY SIGNIFICANT SUBSTANCES.

.V.Sokol'skaya and I.E.El'piner.

kust. Zh. (USSR), Vol. 6, No. 2, 263-4 (1960). In Russian.

After aqueous solutions of citric, malic, fumaric and other liphatic acids saturated with molecular oxygen-free nitrogen ere irradiated in hermetically sealed vessels with ultrasonic aves at a frequency of 560 kc/s and intensity of 12 W cm^{-2}, ximes were found to be present, especially with the dibasic acids. he effect was suppressed in the presence of air. Prolonged rradiation produced amino-acids. [English translation in: Soviet hysics—Acoustics (USA), Vol. 6, No. 2, 259-61 (Oct.-Dec., 1960)]. C.B.Allsopp

20760 OBSERVATIONS BY MEANS OF RADIATION CHEMICAL DOSIMETER LIQUID SYSTEMS OF RRADIATION EFFECTS IN SOLID SODIUM CHLORIDE AND OME ORGANIC SOLIDS.

.Westermark, N.Biesert and B.Grapengiesser.

rk.Kemi (Sweden), Vol. 17, Paper 12, 151-64 (1961).

The dissolution of irradiated solid substances, e.g. NaCl and ome organic solids, in a liquid measurement system used in adiation chemistry gives an easily measurable response. The ffect increases with dose and has a similar saturation tendency that found for F-centre formation. An attempt was made to nterpret the results in terms of the radiation-equivalent part of he stored energy.

20761 RADIOLYSES BY TRANSFERRED ENERGY OF COMPOUNDS DISPERSED IN ALKALI HALIDE ATRICES. A.R.Jones.

. chem. Phys. (USA), Vol. 35, No. 2, 751-2 (Aug., 1961).

Alkali halide crystals and solutions of test substances were mixed and dried in a stream of warm air with continuous grinding. The powder was then compressed to pellets of 400 mg, exposed to amma or electron radiation, and decomposition yields of the test ubstances were measured. Ferrous sulphate dosimetry corrected or mass absorption coefficients was used. G disappearance based n energy absorbed by the potassium bromide matrix was found to e: NH_4Br, 0.16; $KBrO_3$, 0.12; KNO_3, 0.96; KNO_2, 0.52; for concentrations of 0.03 mole %; KNO_3, 0.20 for a concentration of 0.003 mole %; succinic acid 0.54, glutaric acid 1.60 for concentrations of .10 mole %. This system is recommended for the study of energy ransfer in solids. M.Ebert

20762 STUDY OF THE EFFECT OF GAMMA RADIATION ON THE MOLECULE OF PENTOBARBITAL.

J.A.R.Cloutier, B.C.Flann and J.M.Manson.

Canad. J. Phys., Vol. 39, No. 10, 1465-76 (Oct., 1961).

Modern instrumental techniques were used to investigate the effect. The results were correlated with each other and with those from a biological test. The main effect of radiation appeared to be centred about the two substituents of the molecule at the number 5 position.

20763 THE OH YIELD IN THE Co^{60} γ RADIOLYSIS OF HNO_3.

H.A.Mahlman.

J. chem. Phys. (USA), Vol. 35, No. 3, 936-9 (Sept., 1961).

The Co^{60} γ-ray radiolysis of concentrated aqueous solutions was investigated and interpreted as the composite of two mechanisms,

a molecular process $HNO_3 \rightsquigarrow HNO_3^* \rightarrow HNO_2 + \frac{1}{2} O_2$

and a radical process $HNO_3 \rightsquigarrow HNO_3^* \rightarrow OH + NO_2$.

Designation of these mechanisms as molecular and radical is a consequence of the products detected. The existence of these two decomposition mechanisms was gleaned from the determination of the $G(H_2)$, $G(O_2)$, G_{OH}, $G(Ce^{+3})_{\text{No Tl}^+}$, and $G(Ce^{+3})_{\text{Tl}^+}$ and a comparison of these yields with those determined in comparable aqueous $NaNO_3$ solutions. The G_{OH} observed in HNO_3 solutions was found to be directly proportional to the HNO_3 concentration rather than a constant as was observed in comparable $NaNO_3$ solutions. The radical process is appreciable, increasing from 0 at zero HNO_3 concentration to 1.89 at 7 M HNO_3. The data present for the first time evidence of a direct effect upon concentrated aqueous nitrate solutions that is directly proportional to nitrate concentration.

20764 γ-RAY DECOMPOSITION OF SOLID AMMONIUM NITRATE.

T.Shirai, N.Matsuura, M.Nishikawa and M.Takizawa.

Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, No. 2, 219-22 (June, 1960).

The radiation decomposition of solid ammonium nitrate by Co^{60} γ-rays was investigated. Decomposition products were N_2O, N_2, H_2O and nitrite. "G"-values for the production of these gases were estimated. A mechanism for the decomposition of the salt is suggested.

20765 RADIOCHEMICAL GRAFTING [OF POLYMERS] BY IRRADIATION AT LOW TEMPERATURES.

J.R.Puig and J.Dobó.

Internat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 2-3, 112-15 (April, 1961). In French.

Radiochemical grafting of styrolene onto polyethylene was achieved by the simultaneous irradiation of the polymer and the monomer at low temperature. Grafting takes place almost entirely after the irradiation when the specimen has warmed up to room temperature. The reaction is all the more efficient if the polymer is free of reducing agent. The presence of molecular oxygen appears to hinder homopolymerization and to favour copolymerization. The samples produced are free from homopolymer occlusion like those obtained by pre-irradiation in a vacuum. The conditions required for a homogeneous distribution of grafts in the thickness of the polymer are discussed.

20766 CHEMISTRY OF POSITIVE IONS. I. GENERAL THEORY PARTICULARLY FOR THE RADIATION INDUCED CROSS LINKAGE OF POLYMERS AND POLYMERIZATION OF SATURATED HYDROCARBONS. W.F.Libby.

J. chem. Phys. (USA), Vol. 35, No. 5, 1714-22 (Nov., 1961).

The chemical properties of positive ions are considered to be analogous to those of the corresponding neutral atom or molecule. However, the charge strengthens bonds and provides the long-ranged attractive polarization force which causes the reaction cross-sections to be very large. For organic ions dehydrogenation to form carbonium ions occurs frequently, so in addition to the parent ion radical with its great reactivity as a type of super fluorine atom, the carbonium ions with their extremely acidic (electrophilic) properties cause a wholly different set of reactions. These are analogous to those of carbene and may lead to the radiation-induced polymerization of saturated aliphatic hydrocarbons. Both ion radicals and carbonium ions can play important roles in the radiation-induced cross linkage of polyethylene and other polymers. It is predicted that the effect of phase will be very important in radiation chemistry, because the cage effect of the surrounding close-packed molecules in the liquid and solid phase, as contrasted with the gas phase, will cause the fragmentation of the parent ions which is so marked in the gas phase, to be reversed to a considerable extent and promote the formation of large molecules, particularly polymers.

20767 MATHEMATICAL CONSIDERATIONS ON CHEMICAL KINETICS OF RADIATION-INDUCED POLYMERIZATION.

A.Amemiya and M.Inokuti.

J. Phys. Soc. Japan, Vol. 16, No. 5, 949-60 (May, 1961).

The implication of the "stationary state" hypothesis, currently employed in kinetic treatments, is carefully examined. It is shown that the hypothesis is valid only in a certain time interval. Qualitative bahaviours of the total number of polymer radicals as well as of polymer molecules as a function of time are derived without resorting to the stationary state hypothesis. In particular, the asymptotic behaviour of the total number of radicals proves to be senitive to the mode of the termination reaction. It is also confirmed that the molecular size distribution approaches to Poisson type asymptotically.

20768 RADIOMETRIC CHEMISTRY FOR AUTOMATIC PROCESS CONTROL. B.J.Scott and W.J.Driscoll.
Nucleonics (USA), Vol. 19, No. 6, 49-52 (June, 1961).

The methods used for measurement of a chemical process parameter by using the ability of a constituent to combine with a radioactive agent or to reduce the specific activity of one of the constituents are reviewed and the accuracy obtainable discussed. These methods have several advantages, notably that radiometric measurement produces an electrical signal that can be used as input for automatic equipment. R.D.Smith

CHEMICAL EFFECT OF X-RAYS. See Abstr. 15360

DECOMPOSITION OF LEAD IODIDE BY ELECTRON IRRADIATION. See Abstr. 17589

OBSERVATIONS OF LIGHT EMITTED UPON DISSOLUTION IN LUMINESCENT LIQUIDS OF IRRADIATED NaCl, LiF, KI AND SOME ORGANIC SOLIDS. See Abstr. 18415

DISPERSIONS . COLLOIDS

20769 THEORY OF COINCIDENCE IN COULTER PARTICLE COUNTERS. M.Wales and J.N.Wilson.
Rev. sci. Instrum. (USA), Vol. 32, No. 10, 1132-6 (Oct., 1961).

Theoretical relations are developed for the effect of coincidence (simultaneous arrival of two or more particles in the sensing zone) on the observed particle count in a Coulter counter, a device for counting particles in liquid suspensions. Two limiting cases are treated: (a) two or more particles are seen as a particle whose volume is the total particle volume present, (b) two or more particles are seen as the largest particle present. The theory was tested experimentally with a "monodisperse" polystyrene latex. It is shown that absolute particle volumes may be obtained from the ratio of solids content to number of counts under certain conditions. Case (b) coincidence predominates. The apparent breadth of the particle-size distribution curves in the "monodisperse" latex was greater than expected.

AXIAL MIGRATION OF PARTICLES IN POISEUILLE FLOW. See Abstr. 15791

ON THE TENSOR FORM OF DISPERSION IN POROUS MEDIA. See Abstr. 15834

SPECTROTURBIDIMETRY OF EMULSIONS. See Abstr. 16072

INVESTIGATIONS ON SUSPENDED PARTICLES IN DIFFUSING GASES. See Abstr. 15949

20770 AEROSOLS AS CARRIERS OF NATURAL RADIOACTIVITY. K.Stierstadt and M.Papp.
Atomkernenergie (Germany), Vol. 5, No. 12, 459-61 (Dec., 1960). In German.

An apparatus is described for the ionization and mobility-analysis of a naturally occurring aerosol. The natural β-activity of the particles was used as an indicator; 65% of the activity is carried by particles of radii between 1 and 13×10^{-7} cm. Within this range, there is essentially no preference as to particle size. The results are compared with similar measurements by Wilkening (Abstr. 3158 of 1952).

PREPARATION OF AEROSOLS FOR ELECTRON-MICROSCOPY. See Abstr. 20712

20771 SELF-NUCLEATION IN THE SULFURIC ACID—WATER SYSTEM. G.J.Doyle.
J. chem. Phys. (USA), Vol. 35, No. 3, 795-9 (Sept., 1961).

Reiss' "Vector model" (Abstr. 7222 of 1952) was adapted to calculate the self-nucleation rate for the sulphuric acid—water system and similar systems. A numerical calculation was carrie out for the typical case of 50% relative humidity at 25°C. It was concluded that rapid self-nucleation would take place at sulphuric acid partial pressures in the range 10^{-8}-10^{-10} mm Hg. The considerable uncertainty is principally due to lack of data on the partial pressure of sulphuric acid above its aqueous solutions and on the dominant sulphuric acid-bearing species in humid atmospheres.

20772 X-RAY LOW-ANGLE SCATTERING BY DILUTE COLLOIDAL SYSTEMS. THE CALCULATION OF SCATTERING CURVES OF PARALLELEPIPEDS.
P.Mittelbach and G.Porod.
Acta phys. Austriaca, Vol. 14, No. 2, 185-211 (1961). In German.

A general formula for scattering by prisms is obtained, in terms of definite integrals. This is evaluated numerically for the case of parallelepipeds of various dimensions, and the results are represented graphically and by tables. A.R.Stoke

20773 ON THE DETERMINATION OF MICELLAR CHARGE FROM LIGHT SCATTERING EXPERIMENTS.
R.H.Ottewill and H.C.Parreira.
An. Acad. Brasil. Cienc., Vol. 32, No. 2, 225-9 (1960).

By the use of an osmotic pressure equation, containing Debye–Hückel corrections for activity coefficients, a light scattering equation is obtained in terms of the real charge Z rather than the ideal charge p. The treatment is then developed in a form which allows Z to be calculated from p by the use of a correction term. It is clear from the treatment that although an experimental determination may yield a $K(c - c_0)/R_{90}$ versus $(c - c_0)$ curve of zero slop this does not necessarily mean that the micelle is uncharged. Consideration of experimental data for dodecylpyridinium iodide shows that at salt concentrations greater than 0.01 M the correction facto becomes small and Z and p rapidly become identical.

METHOD FOR MEASURING DYNAMIC MECHANICAL PROPERTIES OF GELS; THE GELATION OF POLYVINYL CHLORIDE. See Abstr. 18349

20774 INVESTIGATION OF THE DEPENDENCE OF THE PROCESS OF EMULSIFICATION ON ULTRASONIC INTENSITY. S.A.Neduzhii.
Akust. Zh. (USSR), Vol. 7, No. 1, 99-100 (1961). In Russian.

Irradiation with 22 kc/s ultrasonics, up to 4 W/cm² intensity, of a double layer consisting of $\lambda/2$ of water and $\lambda/2$ of dibutyl pthalate oil shows the threshold intensity for onset of emulsification is 0.5 W/cm² for oil/water and about 1·5 W/cm² for water/oil emulsion. The dependence of limiting concentration on intensity is more strongly pronounced for the oil/water type. [English translation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 79-8 (July-Sept., 1961)]. V.J.Hammon

PHYSICAL METHODS OF CHEMICAL ANALYSIS

20775 CONSTRUCTION AND OPERATION OF A SIMPLE FLAME-IONIZATION DETECTOR FOR GAS CHROMATOGRAPHY. D.J.Morgan.
J. sci. Instrum. (GB), Vol. 38, No. 12, 501-3 (Dec., 1961).

20776 LABELED ORGANICS IN GAS CHROMATOGRAPHY. F.Cacace.
Nucleonics (USA), Vol. 19, No. 5, 45-50 (May, 1961).

Radioisotopes make it possible to recognise separations with increased selectivity. In addition gas chromatography is often the most effective method of separation of labelled compounds. The article reviews techniques available, including a new method for C^{14}-labelled compounds depending on conversion of the vapours in the effluent into CO_2. R.D.Smi

20777 DETERMINATION OF THE SPECIFIC ACTIVITY OF TRITIATED COMPOUNDS ON PAPER CHROMATO- AMS USING AN AUTOMATIC SCANNING DEVICE.
J.Carleton and H.R.Roberts.
ernat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 2-3, -85 (April, 1961).

The specific counting of low-energy beta emitters has hereto- e involved complex radiochemical procedures. Paper chromato- aphy offers a simpler means of separating components of complex ctures. An automatic scanning device allows radiochemical unting procedures to be done directly from the paper chromato- ams. Quantitative assays of specific tritiated compounds are ade direcly from paper chromatograms. The method of cali- ation is described.

20778 MEASUREMENT OF ELEMENTARY SULPHUR-35 WITH A LIQUID SCINTILLATION COUNTER.
K.Bothe and G.Wangermann.
onatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 1, . 7-10, 420-3 (1959). In German.

The radioactive isotope content in S may be determined by ssolving the element in the scintillator liquid (xylene containing BD or PTP), but quenching of the fluorescence becomes significant >0.1 g sulphur litre^{-1} for PBD solution and > 0.02 g sulphur re^{-1} for PTP solution. A diagram shows the linear relation tween counting rate and S^{35} content in the low range, and another e decrease of fluorescence at higher concentrations.

S.T.Henderson

20779 OZONE ANALYZER USES RADIOACTIVE CLATHRATE.
.O.Hommel, D.Chleck and F.J.Brousaides.
ucleonics (USA), Vol. 19, No. 5, 94, 96, 98, 100, 102 (May, 1961).

The gas is passed through a molecular sieve drier and over a r^{85} quinol clathrate. Ozone oxidizes quinol and releases Kr^{85} hich is counted with a thin-walled Geiger counter. With a clath- ate specific activity of 1 curie/g, ozone concentrations of less han 5×10^{-11} by weight give a counting rate of 100 counts/min.

R.D.Smith

20780 PANORAMIC DELAYLESS ANALYSER FOR MULTI-COMPONENT GAS MIXTURES (PGA-1).
.N.Rubinshtein and V.I.Fistul'.
ribory i Tekh. Eksper. (USSR), 1958, No. 4, 82-8 (July-Aug.).
Russian.

A description is given of a gas analyser which uses a pulsed ass spectrometer in which no magnets are employed. The strument can record transient precesses as short as 2 msec. he presentation is in the form of a panoramic display on the creen of an oscilloscope tube. [English translation in: Instrum. xper. Tech. (USA), No. 4, 547-54 (July-Aug., 1958; publ. June, 1959)].

20781 THE SEPARATION OF GASEOUS MIXTURES BY A VAPOUR CURRENT. A.S.Kompanejez.
nn. Phys. (Germany), Vol. 8, No. 5-6. 303-6 (1961). In German.

The efficiency of the separation of a mixture of two gaseous omponents with nearly equal diffusion coefficients through a vapour urrent is considered as a function of the distance along the axis f the separation column.

D. ter Haar

20782 LOW-VELOCITY GAS—LIQUID IMPINGER FOR THE CONTINUOUS ESTIMATION OF SULPHUR DIOXIDE AND OTHER ATMOSPHERIC POLLUTANTS. T.Nash.
J. sci. Instrum. (GB), Vol. 38, No. 12, 480-3 (Dec., 1961).

The instrument records sulphur dioxide conductimetrically in the range 0·01 to 10 parts per million in cases where rapid changes in concentration can be expected but the accuracy required is not more than 1 in 20. Sampling is continuous and cumulative, with a return to initial conditions two or three times an hour. The principle of operation is the removal of a soluble vapour from an air jet impinging on to an unbroken liquid surface. One modification of the instrument measures light absorption instead of conductivity, permitting the use of colorimetric reagents.

20783 PRODUCTION OF ACCURATE GAS AND VAPOUR MIXTURES. D.W.Hill.
Brit. J. appl. Phys., Vol. 12, No. 8, 410-13 (Aug., 1961).

With the increasing use of physical methods of gas and vapour analysis, there is a need for a convenient means of calibration. It is confirmed that the use of gas and vapour mixtures stored in cylinders under pressure is a suitable method. Such mixtures are stable with time. The analysis of gas and vapour mixtures has been found to agree to within 1% of the calculated value.

20784 MASS SPECTROMETRIC INVESTIGATION OF THE DEGASSING PRODUCTS FROM MAGNESIUM WHICH CONTAINS HYDROGEN AND SILICON. K.Bornkessel and J.Pilot.
Z. Naturforsch. (Germany), Vol. 16a, No. 4, 432-4 (April, 1961).
In German.

Evidence was obtained for the liberation of an unstable silicon hydride, such as SiH, SiH_2, or SiH_3 during the hot extraction of magnesium which contains both hydrogen and silicon. The mass spectrum in the range from 28 to 34 mass numbers showed a peak at mass number 30 that is caused mainly by SiH_2. The peak at mass number 29 is a clear indication of the presence of SiH. At a degassing temperature of 500°C, the ratio of at.% H:Si is approximately 2 : 1.

R.Schnurmann

20785 SPECTROMETRY OF X-RADIATION EXCITED BY A RADIOACTIVE SOURCE EMITTING β-RAYS.
G.Seibel, P.Martinelli and H.Franco.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 4, 232-4 (Oct., 1960). In French.

A radioactive source is used to direct β-rays against a compound target and the resultant characteristic X-radiation is measured. Analysis by this means is vitiated by the presence of a high background count. Experiment shows that, for some critical activity of the source, the sensitivity may be optimized. In this way quantities of Cu and Fe constituting less than 1% of a specimen may be measured.

A.E.I. Research Laboratory

20786 X-RAY SPECTROMETRY WITH RADIOACTIVE SOURCES. J.F.Cameron and J.R.Rhodes.
Nucleonics (USA), Vol. 19, No. 6, 53-7 (June, 1961).

A source is mounted on a thick backing in the centre of the thin window of a proportional counter. Fluorescent X-rays are excited in a sample placed a few mm in front of the source and detected by the counter. Pulse height analysis is used to identify the X-ray energy. Suitable sources include tritium and Pm^{147} bremsstrahlung sources and Am^{241}. The practical applications are discussed in detail, showing how the use of filters to eliminate unwanted radiation enables analyses of simple systems such as alloys or the measurement of thin films on a thick backing (e.g. paint) to be made.

R.D.Smith

20787 INVESTIGATIONS IN QUANTITATIVE X-RAY FLUORESCENCE ANALYSIS.
H.J.Seemann, G.Schmidt and F.Stavenow.
Z. Naturforsch. (Germany), Vol. 16a, No. 1, 25-30 (Jan., 1961).
In German.

A brief description of the standard method is given. Calculations for a two-component material give values of emitted X-ray intensity in agreement with experiment for a Ni—Fe alloy, but extension to more complex mixtures gives equations from which the determination of composition is unsatisfactory. This situation is remedied by using the material for analysis in dilute aqueous solution.

S.T.Henderson

20788 EFFECT OF SUPERPOSITION OF THE ABSORPTION SPECTRA OF THE COMPONENT BEING DETERMINED AND AN INTERFERING COMPONENT IN ABSORPTION SPECTRAL ANALYSIS. A.O.Sall'.
Optika i Spektrosk. (USSR), Vol. 10, No. 6, 806-8 (June, 1961).
In Russian.

Formulae are derived for two basic designs of absorption analysers to give an estimate of the error caused by changing the content of interfering component in the mixture being analysed. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 6, 426-8 (June, 1961)].

G.I.W.Llewelyn

LIGHT SOURCES FOR THE FAR ULTRAVIOLET AND THEIR APPLICATION TO SPECTROCHEMICAL ANALYSIS.
See Abstr. 16088

THE SPECTROSCOPIC ESTIMATION OF BORON IN SILICON.
See Abstr. 19864

GEOPHYSICS

20789 ENERGY REQUIREMENTS OF AN EXPANDING EARTH.

A.E.Beck.

J. geophys. Res. (USA), Vol. 66, No. 5; 1485-90 (May, 1961).

To estimate the energy required for, and hence the physical possibility of, an expanding earth, the gravitational potential energy of the present earth and of various primitive earth models are compared. If the primitive density distribution is given by $\rho r = \rho_0(1 - kr^n)$, then, with plausible values of ρ_0, k, and n, expansions of the radius of about 100 km, with a net loss of gravitational potential energy, cannot be ruled out. Earth models with moments of inertia higher or lower than that of the present earth can be selected from the range of plausible smaller primitive models available for each value of n. Expansions of the radius of about 1000 km can be entertained only if highly improbable density distributions are assumed. The conclusions are not substantially altered even when additional sources of energy are taken into account.

EFFECTS OF THE EQUATORIAL ASYMMETRY OF THE EARTH ON THE ORBIT OF AN ARTIFICIAL SATELLITE.

See Abstr. 18216

20790 THE COMPARISON OF THE EARTH'S GRAVITATIONAL POTENTIAL DERIVED FROM SATELLITE OBSERVATIONS WITH GRAVITY OBSERVATIONS ON THE SURFACE.

A.H.Cook.

Geophys. J. (GB), Vol. 5, No. 1, 29-33 (May, 1961).

Instead of regarding gravity as a function of height above sea-level and angular coordinates, it may be regarded as a function of geopotential and angular coordinates. Since the operations of spirit levelling give differences of geopotential directly, observed values of gravity on the surface of the earth are obtained as functions of geopotential, while gravity as a function of geopotential may be calculated from the expression for the potential derived from satellite observations. Comparing these two functions, one obtains differences between observed and calculated gravity at the same values of geopotential, the most direct possible comparison between the two sets of observational data.

20791 ODD HARMONICS OF THE EARTH'S GRAVITATIONAL FIELD.

R.R.Newton, H.S.Hopfield and R.C.Kline.

Nature (GB), Vol. 190, 617-19 (May 13, 1961).

Variations in the perigee radius, observed for three satellites, were used to determine the third, fifth and seventh axial harmonics of the earth's gravitational field. G.M.Brown

20792 SOME THEORETICAL CONSIDERATIONS IN THE MEASUREMENT OF GRAVITY AT SEA.

L.J.B.LaCoste and J.C.Harrison.

Geophys. J. (GB), Vol. 5, No. 2, 89-103 (July, 1961).

The theory of operation of spring gravity meters on a stabilized platform in the presence of horizontal and vertical accelerations is considered in the first section of this paper. It is shown that levelling errors with the same period as the horizontal accelerations are very important. The amplitude of such levelling errors should not exceed about 8 seconds of arc when the amplitude of the horizontal accelerations is 50 000 mgal. A second effect, which is present even on a perfectly stabilized platform, has been named the "cross coupling" effect. It is produced by coupling between the vertical and horizontal accelerations and may, for a typical gravity meter, cause an error in excess of 100 mgal when the horizontal and vertical accelerations both have amplitudes of 50 000 mgal. The second part of the paper is devoted to a discussion of a gravity meter free to swing in gimbals. An expression for the second-order correction is derived taking into account free and forced oscillations of the gimbal system. This expression takes an especially simple form $\frac{1}{2}g\theta^2$ (θ is the deflection of the gimbal system from the true vertical) when the gravity sensing element is positioned at the correct distance below the gimbal axis.

20793 THE INTERPOLATION OF EARTH-TIDE RECORDS.

I.M.Longman.

J. geophys. Res. (USA), Vol. 65, No. 11, 3801-3 (Nov., 1960).

A method is presented whereby earth-tide gravity records can conveniently be interpolated. It is based on the theoretical rigid-earth gravity tide $g_0(t)$ and its time derivative. The possibility is envisaged that earth-tide gravity records for any station may be generated in their entirety by this method for any station for which a pair of constants has been determined.

20794 HEAT FLOW FROM A DIFFERENTIATED EARTH.

S.P.Clark,Jr.

J. geophys. Res. (USA), Vol. 66, No. 4, 1231-4 (April, 1961).

Calculations are made of the heat flow from an initially cold earth with radioactivity distributed uniformly through a surface shell, with account taken of radioactive decay. It is found that the heat flow exceeds the heat produced by about 10% if the abundances of radioactive elements are the same as in chondrites and the radioactive shell is less than about 300 km thick. The heat flow calculated in this way exceeds the observed value, but neither figure is considered to be known accurately enough to warrant rejection of the chondrite model of the earth.

20795 SURFACE HEAT FLOW FROM A DIFFERENTIATED EARTH.

G.J.F.MacDonald.

J. geophys. Res. (USA), Vol. 66, No. 8, 2489-93 (Aug., 1961).

Numerical calculations were carried out on the development of surface heat flow in model earths. The bulk radioactivity of the earth is taken equal to that of chondritic meteorites. The initial temperature reaches 2600° at 1200 km. The heat flow for a model in which the radioactivity is uniformly distributed in the outer 600 km is 90 ergs cm^{-2} sec^{-1}. If the radioactivity is concentrated in the outer 100 km, the present-day surface heat flow is 68 ergs cm^{-2} sec^{-1}. The initial heat contributes about one-fifth the surface heat flow. The examination of the relations between initial heat, radioactive distribution, and heat flow suggests that if the earth has the radioactive composition of chondritic meteorites, then a near-surface concentration of heat sources must have proceeded at temperatures well below the melting point of silicates. Radioactivity lower by a factor of 2 would remove the indicated discrepancies.

20796 RADIATION OF SEISMIC SURFACE-WAVES FROM FINITE MOVING SOURCES.

Ari Ben-Menahem.

Bull. Seismol. Soc. Amer., Vol. 51, No. 3, 401-35 (July, 1961).

A theory is proposed for the propagation of seismic surface-waves from finite moving sources. The method consists of obtaining, in the first place, basic solutions for surface displacements from directional sources. These solutions are integrated to obtain the effect of a moving fault with arbitrary dip angle. Displacements are evaluated for Rayleigh and Love waves at long ranges. It is shown that the dimensions of the source and the speed of rupture play an important role in the wave-pattern and cannot be ignored whenever the dimensions of the source are of the order of the radiation's dominant wavelength. It is demonstrated how this theory may lead to a derivation of the velocity of rupture and the length of faulting from seismic records of a single station.

20797 TERRESTRIAL SPECTROSCOPY.

C.L.Pekeris, Z.Alterman and H.Jarosch.

Nature (GB), Vol. 190, 498-500 (May 6, 1961).

Attempts the verification of Larmor's analogy (effect of rotation on the frequency of mechanical systems). Multiplets of the terrestial spectrum are calculated for the Gutenberg model of the earth and are compared with observed multiplets caused by the great Chilean earthquake (22 May, 1960). Both gravitational and seismic waves are studied. The doublets observed are those lines of the multiplet which are strongest theoretically, while the weak lines are missing since they are not expected to stand out above the observed noise level. J.K.Skwirzynski

20798 ELECTROMAGNETIC PROBING OF DEEP EARTH STRATA.

A.N.Tikhonov, N.V.Lipskaya, N.A.Deniskin, N.N.Nikiforova and Z.D.Lomakina.

Dokl. Akad. Nauk SSSR, Vol. 140, No. 3, 587-90 (Sept. 21, 1961). In Russian.

The fundamental experimental material for deep probing was obtained from (1) records of the natural electromagnetic field of the arth (Alushta geophysical station, Crimea; periods varied from sec to 3 hours; quartz micro-variometers were used, and) records of telluric current (Shatsk station) and of magnetic field Central Magnetic Observatory). The Alushta results were used to alculate the relation between log ρ_k (logarithm of the apparent esistance) and log($T^{1/2}$). Lower frequency readings (periods up 20 hr), obtained from the Shatsk results, fitted the right-hand symptote of the Alushta curve fairly well. Owing to the fficulties of interpretation of curves of apparent resistance, any oint on such a curve yields either the total thickness or the total ngitudinal resistance, the former when then asymptote in the arge period range is descending, the latter when it is ascending, e slope being respectively ~ −2 or 2. The thickness of the top acket of strata and the depth at which the high-conductivity foundation begins are determined easily from an equation; the conductivity and thickness of the intermediate strata can be determined following cumbrous approximations and calculations by eans of special theoretical curves. It was found that the phericity of the earth and variations of the wave structure ntroduce only slight corrections to the value of ρ_k. [English ranslation in: Soviet Physics—Doklady (USA)]. F.Lachman

20799 ON THE STRONG COUPLING BETWEEN THE MANTLE AND THE CORE OF THE EARTH.

N.Sekiguchi.

Publ. Astron. Soc. Japan, Vol. 13, No. 1, 23-50 (1961).

The difficulties pointed out by H.Jeffreys in his theories on the fluidity of the earth's core, can be explained by supposing there is a strong mechanical coupling between the core and the mantle of the earth. This coupling may be due to a strong magnetic field generated at the core boundary, which causes the secular variation of the geomagnetism.

20800 MAIN CHARACTERISTICS OF PULSATIONS OF THE EARTH'S ELECTROMAGNETIC FIELD IN JULY 1959.

V.A.Troitskaya, O.V.Bolshakova, M.V.Melnikova, K.Y.Sergeeva, N.N.Sukhareva and R.V.Shchepetrov

"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 84-93.

Earth-current pulsations associated with the solar events on the dates cited, and recorded at 8 stations in the USSR, are described and discussed from the point of view of the micro-structure of concurrent geomagnetic field changes. D.R.Barber

20801 ESSAY ON THE INTERNAL ELECTRICAL CONSTITUTION OF THE EARTH.

L.Cagniard.

C.R. Acad. Sci. (France), Vol. 253, No. 3, 504-6 (July 17, 1961). In French.

The view is expressed that in the transmission from mantle to core at 2900 km there is a discontinuous increase of density and rigidity due to weakening of the molecular structure. Electrons become free and electric conductivity is comparable to that of a metal. Electrons are expelled from the core to form the negative external face of a double layer whose presence at the common boundary explains terrestrial magnetism. Electric force in the layer causes an increase of pressure and when a critical value is reached structural breakdown occurs. A new increase of pressure liberates more electrons and a chain reaction occurs to produce hyper electric conductivity in the layer, with the material, under millions of atmospheric pressures, in a highly condensed state. R.S.Read

20802 RADIATION RESISTANCE OF A VERTICAL MAGNETIC DIPOLE OVER AN INHOMOGENEOUS EARTH.

J.G.Negi.

Geophysics (USA), Vol. 26, No. 5, 635-42 (Oct., 1961).

The expressions for the energy radiated per second from an oscillating vertical magnetic dipole situated above a two-layer earth are derived. Of the three important cases to which particular attention has been given, the first and the second involve the presence of a conducting and insulating substratum, respectively. The third deals with a dipole placed over a thin conducting sheet of infinite extent. Appropriate approximations are made such that the results may be useful for geoelectrical exploration.

20803 EARTH CURRENTS OF DEEP INTERNAL ORIGIN.

P.H.Roberts and F.J.Lowes.

J. geophys. Res. (USA), Vol. 66, No. 4, 1243-54 (April, 1961).

The current system flowing in the earth's core that is responsible for the dipole geomagnetic field is toroidal and does not appreciably extend into the mantle. However, the mechanism supporting these currents almost certainly generates in addition a poloidal current system that does extend into the mantle and that could, in principle, be measured at the earth's surface. The current distribution in the mantle is examined for several assumed distributions of conductivity in the mantle. The effect of the oceans is also briefly considered. It is found that the potential gradient at the surface of the earth associated with these deep earth currents may be of the order of a mV km^{-1} if thermoelectric e.m.f.'s at the core boundary contribute appreciably to the magnetic field, but will be smaller if the primary e.m.f.'s are inside the core.

THE REFLECTION OF RADIO WAVES FROM AN ICESHELF. See Abstr. 16562

A THEORETICAL STUDY OF WAVES BREAKING AT AN ANGLE WITH A SHORE LINE. See Abstr. 15813

20804 SOME SPECTRAL IRRADIANCE MEASUREMENTS OF UPWELLING NATURAL LIGHT OFF THE EAST COAST OF THE UNITED STATES.

G.L.Stamm and R.A.Langel.

J. Opt. Soc. Amer., Vol. 51, No. 10, 1090-4 (Oct., 1961).

Upwelling natural light from the sea during daylight may originate from reflection from the sea bottom, scattering from within the sea, or reflection from the sea surface. Spectra of upwelling light were photographed from an aircraft at various places over the sea off the eastern coast of the United States. Subsequent calibration of the spectroscopic plates resulted in data which gave spectral irradiances on the underside of a flat, horizontal surface over the water. Curves of spectral irradiances were drawn for various locations and for different sea and atmospheric conditions. All curves were low in the red and rose gradually toward the blue; for example, over water off North Carolina near the Gulf Stream the irradiance was 4.0 $\mu w \times cm^{-2} \times m\mu^{-1}$ at 700 mμ and 18.6 $\mu w \times cm^{-2} \times m\mu^{-1}$ at 430 mμ. This result was typical of deep, clear water in clear weather at midday. Closer to shore in shallow and less clear water, irradiances peaked at about 450 mμ and decreased at shorter wavelengths. The curves showed evidence of the green colour of this water. The measured spectral radiances of deep water were higher in the red than theoretical values which neglect surface reflections.

20805 LONG-RANGE SOUND TRANSMISSION IN THE ARCTIC OCEAN.

H.Kutschale.

J. geophys. Res. (USA), Vol. 66, No. 7, 2189-98 (July, 1961).

Strong hydroacoustic signals from underwater explosions as small as those due to 2 pounds of TNT were detected in the Arctic Ocean at distances up to 1150 km. Hydrophones at depth and geophones on the ice surface were used as listening devices. The signals propagate in the Sofar channel, whose axis in the Arctic Ocean occurs approximately at the surface, but the character of the signals differs markedly from that typical of the nonpolar oceans, largely because of the predominance of low-frequency waves in the Arctic. The character of the arctic Sofar signals is best explained by normal-mode wave propagation in a channel bounded by the surface and by the zone of increasing velocity in the upper several hundred metres of water. Irregularities in the ice boundaries apparently strongly attenuate the high-frequency waves but have a negligible effect on the amplitudes of the low-frequency waves. At least two normal modes were observed. In each normal mode the waves have a nearly sinusoidal appearance with periods decreasing from about 120 to 30 msec in the first mode and from 70 to 40 msec in the second mode. A good quantitative fit between experimental data and theoretical dispersion curves was obtained. The signals were detected in both deep and shallow water.

20806 TERRESTRIAL ACCRETION FROM THE SOLAR WIND.

R.Frith; E.R.Harrison; C.M.de Turville.

Nature (GB), Vol. 191, 1182, 1182-3, 1183-4 (Sept. 16, 1961).

Recently de Turville has suggested (Abstr. 11651 of 1961) that the water of terrestrial oceans was formed initially in the high atmosphere from H_2 supplied by the solar wind. Frith points out that a continuous production of H_2O at levels above 100 km will result in a gradient of the water-vapour mixing ratio decreasing downwards to the point where it is balanced by the upward gradient due to the evaporation of surface water. Observations of ice-clouds at 27 km, and at ~ 80 km support this view. Harrison criticises de Turville's model proton capture from an incident solar wind by the geomagnetic field. In particular he points out that the required wind velocity (4300 km sec^{-1}) implies an energy flux at the earth's orbit as great as 10^{-3} of the total solar flux. In reply, de Turville maintains the correctness of his model; and, using more recent data, he obtains a revised value of H accretion equivalent to a total water mass of 1.23×10^{24} g compared with his previous value of 1.53×10^{24} g. The revised estimate is based on the assumption of a solar wind of unvarying character out to 1.2 A.U. D.R.Barber

ATMOSPHERE

(Troposphere and Stratosphere)

20807 HANDBOOK OF METEOROLOGICAL INSTRUMENTS. II. INSTRUMENTS FOR UPPER AIR OBSERVATIONS.
London: Her Majesty's Stationery Office (1961). 209 pp.

For Pt I see Abstr. 8498 of 1956. A reference book to instruments that are now available for observation to heights of about 40 km. It starts with a survey of the historical development of upper sounding. Six chapters are concerned with the application of radio and radar techniques to the measurement of the physical properties of the free atmosphere and there are chapters on instruments for meteorological observations from aircraft and on the methods of measurement in cloud physics. The volume, which is illustrated with 51 plates and 47 diagrams and is fully indexed, includes a glossary of technical terms and a bibliography.

20808 FREEZING NUCLEI, METEORS, AND RAINFALL. N.H.Fletcher.
Science (USA), Vol. 134, 361-7 (Aug. 11, 1961).

Review article on the possible effects of meteor swarms on the terrestrial rainfall pattern.

20809 MEASUREMENTS OF NO_2 IN THE ATMOSPHERE. O.Tanaevsky.
C. R. Acad. Sci. (France), Vol. 252, No. 19, 2909-11 (May 8, 1961). In French.

Measurements of the percentage by volume of NO_2 in the atmosphere at Beni-Abbes in the Sahara, are compared with those previously made in France. The Sahara mean, 0.6×10^{-6}, is of the same order as measured in industrial and mountainous areas in France. It is inferred that NO_2 is a normal constituent of the atmosphere everywhere. J.M.Stagg

20810 THE TIME OF THE ESTABLISHMENT OF A STATIONARY QUANTITY OF OXYGEN IN THE ATMOSPHERES OF PLANETS CONTAINING WATER VAPOUR. É.K.Byutner.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 5, 1050-3 (June 11, 1961). In Russian.

It is shown, on the basis of certain simple assumptions, that if the physical conditions in the Earth's atmosphere before the rise of organic life were about the same as now, then after about 60 million years, an amount of free oxygen about equal to the contemporarily observed value would have accumulated as a result of interactions between water vapour and solar radiation. The photodissociation of CO is also mentioned. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 6, 454-6 (Dec., 1961). G.A.Chisnall

20811 SOLAR WIND AND TERRESTRIAL OXYGEN. N.W.Pirie.
Nature (GB), Vol. 190, 706 (May 20, 1961).

Questions the widely-held view that the terrestrial atmosphere originally contained little or no O_2, and that primordial life was associated with anaerobic reactions. It is pointed out that the present concentration (230 g/cm^2) is not readily accounted for by any mechanism so far proposed. A recent statement by de Turville (Abstr. 11651 of 1961) suggests that all the H_2 now in the oceans could be provided by the solar wind in $\sim 3 \times 10^9$ years. Thus the associated O_2 locked up in the ocean waters represents a concentration $\sim 10^3$ times that in the atmosphere: a piece of evidence making the problem of the origin of atmospheric O_2 more intractable than ever. D.R.Barber

20812 DETERMINATION OF THE VERTICAL DISTRIBUTION OF OZONE BY SATELLITE PHOTOMETRY.
S.V.Venkateswaran, J.G.Moore and A.J.Krueger.
J. geophys. Res. (USA), Vol. 66, No. 6, 1751-71 (June, 1961).

The Echo communications satellite (1960 Iota I) launched by the United States on August 12, 1960, was designed to be a good reflector of visible solar radiation. Under certain favourable orientations of its orbital plane, ground observers were able to watch it enter (and leave) the earth's shadow. Immediately before and after such observable eclipses, the satellite was illuminated by radiation that had been modified as a result of a long traverse in the earth's atmosphere. In wavelengths near 6000 A, the modification was one of attenuation (extinction) caused by two distinct physical processes: scattering by air molecules, and absorption by ozone present mainly in the lower stratosphere and possessing weak absorption bands (the Chappuis bands). If in this region of the solar spectrum the differential attenuation between a pair of properly selected wavelengths was measured, and the contribution due to differential scattering was subtracted out the differential absorption due to ozone was isolated, and hence the average concentration of this constituent in the path of the solar ray instantaneously incident on the satellite was derived. By making the measurements at successive instants, the altitude distribution of the ozone concentration could also be determined. Even though ozone concentration did not reach values higher than 10^{-8} of the air concentration at any altitude in the earth's atmosphere, the long ray paths involved in the satellite illumination made it possible to determine this concentration with sufficient accuracy. Alternatively, if the wavelengths selected were such that the differential ozone absorption was negligible, a method of determining the air density at various heights from the differential scattering alone appeared to be possible. In this paper the details of the theory are presented, and some preliminary determinations of the ozone distribution obtained by monitoring the Echo satellite in two wavelength bands centred at 5900 and 5295 A respectively are reported.

20813 ON THE DEDUCTION OF THE VERTICAL DISTRIBUTION OF OZONE BY ULTRAVIOLET SPECTRAL MEASUREMENTS FROM A SATELLITE. S.Twomey.
J. geophys. Res. (USA), Vol. 66, No. 7, 2153-62 (July, 1961).

In a simple scattering atmosphere, containing an absorbing constituent that absorbs differently at different wavelengths, the spectral distribution of reflected energy depends on the vertical distribution of the absorbing constituent. In fact, if the vertical distribution is represented by expressing the pressure as an explicit function of the mass of absorbent between the top of the atmosphere and that pressure level, and the spectral energy distribution as an explicit function of absorption coefficient, then, for a model with primary scattering only, the latter function is a Laplace transform of the former. This result can be utilized to obtain an approximate inversion and so to deduce the vertical distribution of the absorbing constituent. Some numerical computations are presented for the case of ozone distribution in the earth's atmosphere.

20814 MERIDIONAL OZONE DISTRIBUTION AND STRATOSPHERIC CIRCULATION.
H.K.Paetzold and F.Piscalar.
Naturwissenschaften (Germany), Vol. 48, No. 13, 474 (1961). In German.

Presents a cross-section of the atmosphere showing the spring and autumn distributions of ozone to 35 km from equator to pole based on the authors' measurements using an optical radiosonde. A second diagram shows how the vertical distribution of ozone observed at Dever (USA) changed from an equatorial type, with a prominent maximum at or above 20 km, to the double type of middle latitudes with one maximum well below that level. The change is related to the pattern of air flow at the 250 mb level. The difference between the observed and the theoretically inferred distributions of ozone are explained in terms of the two main discontinuities in the tropopause and the associated jet streams: a transport time of between six and twelve months is deduced for the ozone to circulate from low to middle latitudes. The possible inferences from the other observed fact that ozone concentration above 35 km in sunspot minimum years is around 25% less than in maximum years are discussed. J.M.Stagg

20815 STRATOSPHERIC AEROSOL STUDIES. C.E.Junge and J.E.Manson.
J. geophys. Res. (USA), Vol. 66, No. 7, 2163-82 (July, 1961).

The stratospheric aerosol layer previously identified by balloon measurements was studied extensively by means of recovered rod impactor samples obtained during aircraft flights at the 20-km level from 63°S to 72°N during March-November 1960. From a variety of physical and chemical measurements, which are presented in detail, the conclusion is drawn that this layer is stable, constant in time and space, and composed mainly of sulphate particles. The various questions raised by this result, particularly with respect to collection of micrometeorites, are presented and discussed.

ENERGY DISSIPATION OF SPIRALLING PARTICLES IN THE POLAR ATMOSPHERE. See Abstr. 20959

20816 THE DUST CLOUD ABOUT THE EARTH.

J.H.Fremlin, D.B.Beard and F.L.Whipple.

Nature (GB), Vol. 191, 31-4 (July 1, 1961).

Commenting on Whipple's original article (Abstr. 6643 of 1961), Fremlin suggests an additional cause of the concentration of circumterrestrial particles, namely, that the latter originate from meteorites grazing the earth's atmosphere. Beard, in turn, presents a theory of particle motion in a geocentric coordinate framework which appears to agree with the result of Whipple's analysis of rocket, satellite, and space-probe observations. In reply, Whipple doubts whether the contribution to the dust-cloud suggested by Fremlin will be a major one; and he points out that, because of the near equality of effective gravitational and geometrical cross-sections of the earth for the type of particle envisaged, Beard's process will be ineffective. D.R.Barber

20817 LATITUDE AND DIURNAL VARIATIONS OF AIR DENSITIES FROM 190 TO 280 Km AS DERIVED FROM THE ORBITS OF DISCOVERER SATELLITES.

G.V.Groves.

Proc. Roy. Soc. A (GB), Vol. 263, No. 1313, 212-16 (1961).

Variations in air density between day and night in the region 190 to 280 km are found to be small (less than about 25%). The presence of a "wiggle" in the curve of log (day-time density) against height indicates a possible region of local heating at about 220 km which disappears at night. The night-time density profile conforms with a constant scale height of 35(±2)km. No definite variation of air density with latitude is evident apart from a possible increase of about 60%, which is indicated by rather limited polar-region data. For other latitudes and seasons a variation of less than about 2% is indicated.

20818 SPECTROSCOPIC OBSERVATIONS OF THE WATER-VAPOUR CONTENT OF THE STRATOSPHERE.

J.T.Houghton and J.S.Seeley.

Quart. J. Roy. Meteorol. Soc. (GB), Vol. 86, 358-70 (July, 1960).

The water-vapour content of the stratosphere has been deduced from records of the solar spectrum observed from a Canberra aircraft at altitudes up to 48 000 ft. The spectral region 3790-3860 cm^{-1} in the 2.7 μ band was separated into four groups of absorption lines whose rates of growth were studied. Measurements in an altitude chamber of the absorption of very small paths of water vapour were used to interpret the aircraft measurements in terms of absolute values of (pressure × quantity of water vapour)$^{1/2}$. Spectroscopic observations were compared with measurements made by the frost-point hygrometer. The overall results show that the water-vapour content in a vertical column above 45 000 ft over southern England is about 4.5 μ, corresponding to a mixing ratio of 3×10^{-6}, if this is assumed constant above the height of observation.

20819 DISTRIBUTION OF WATER VAPOR IN THE STRATOSPHERE.

H.J.Mastenbrook and J.E.Dinger.

J. geophys. Res. (USA), Vol. 66, No. 5, 1437-44 (May, 1961).

The development of a relatively lightweight dew-point radiosonde was coupled with a flight programme to measure the water vapour in the stratosphere. The technique of obtaining data on descent as well as on ascent provided a method for checking the internal consistency of single flight observations. Data from three flights which meet the criterion of such self consistency are presented. One flight gave data which showed an essentially constant mixing ratio of approximately 4×10^{-5} g/g through a stratosphere with some decrease above 72 000 ft. The other two flights show a low water-vapour content in a layer just above the tropopause with a mixing ratio 1/20 that of the first flight at an altitude of 55 000 ft. An increase in water vapour with altitude above this layer is observed, the increase being such as to give a mixing ratio for the three flights which is of the same order of magnitude at 100 000 ft.

20820 TRAJECTORIES: ISOBARIC, ISENTROPIC AND ACTUAL.

E.F.Danielsen.

J. Meteorol. (USA), Vol. 18, No. 4, 479-86 (Aug., 1961).

Vertical and horizontal deviations between an atmospheric air trajectory and isobaric and isentropic trajectories are presented in a convenient form for order-of-magnitude comparisons and interpretation. Also, an objective method for computing isentropic trajectories is developed which is based on the total-energy equation.

20821 ON THE DIRECTION AND DIVERGENCE OF THE SMALL-SCALE TURBULENT HEAT FLUX.

J.W.Deardorff.

J. Meteorol. (USA), Vol. 18, No. 4, 540-8 (Aug., 1961).

The equation describing the production or decay of temperature fluctuations of the n-th moment is derived and applied toward the determination of the sign of the small-scale heat flux and its vertical divergence in the atmosphere. It is found that an upward heat flux is possible within a sub-adiabatic layer surmounting a super-adiabatic layer if the potential temperature does not increase with height by more than about 0.2 deg C within the layer. The vertical divergence of the heat flux in an unstable surface layer is found to be positive close to the ground, thereby compensating somewhat for strong radiational heating. It is found to be negative higher above the surface where the potential temperature decreases much more slowly with height provided the temperature variance diminishes with height. The divergence appears to be positive (negative) at the lower (upper) surface of an inversion and could therefore be a mechanism of maintenance of such a surface against the destructive effect of radiation.

20822 ENERGY TRANSFORMATION AND VERTICAL FLUX PROCESSES OVER THE NORTHERN HEMISPHERE.

C.E.Jensen.

J. geophys. Res. (USA), Vol. 66, No. 4, 1145-56 (April, 1961).

Three integrals in the mechanical energy equation were statistically evaluated as a function of a broad division of eddies in the atmosphere over the northern hemisphere for January and April 1958. The integral of the product of the instantaneous pressure change and the specific volume exhibits two significant positive (potential to kinetic energy) modes, one in the boundary region from 1000 to 850 mb and the other in the middle troposphere from 700 to 500 mb. The integral values of the product of the instantaneous pressure change and the potential energy are about an order of magnitude larger than the values computed for the integral representing the transport of kinetic energy. The three integral values were introduced into the mechanical energy equation and the residual was taken, ideally at least, to represent the dissipation rate for the horizontal kinetic energy within various regions of the atmosphere up to 50 mb. These dissipation rates compare favourably with the appropriate estimates by Brunt (1941).

20823 THE SUDDEN ONSET OF EASTERLY WINDS IN WINTER IN THE MIDDLE AND HIGHER STRATOSPHERE AND THE PROGRESSIVE EXTENSION OF THE CHANGE NORTHWARDS FROM 20° TO 50° LATITUDE IN THE NEIGHBOURHOOD OF THE PARIS MERIDIAN.

G.Barbé.

C.R. Acad. Sci. (France), Vol. 252, No. 24, 3845-7 (June 12, 1961). In French.

The results, in diagrammatic form, are presented of measurements of wind speed and direction at heights from 15 to 35 km at four stations in the latter part of January and early February 1960. The four stations were in approximate latitudes 20°, 27°, 32° and 50° along the Paris meridian. In this period the normal winter westerly circulation changed temporarily to an easterly direction. The change started first in the south, made its appearance about five days later in the north and was confined to the layer between about 20 km and 30 km. The circulation reverted to the normal winter westerly about ten days later. The cause of temporary changes of this kind is tentatively discussed in terms of heating of a layered patch of the high atmosphere, so reversing the horizontal north—south pressure gradient. J.M.Stagg

20824 VARIATIONS OF WIND SPEED AND OZONE CONCENTRATION.

M.Kiveliovitch and A.Vassy.

C.R. Acad. Sci. (France), Vol. 252, No. 24, 3848-50 (June 12, 1961). In French.

Six years' measurements at 3-hourly intervals of wind speed and ozone concentration near the ground at Val-Joyeux suggest that the speed and the ozone are positively correlated though not in a simple way. An increase of speed is associated with an increase of ozone, but the consequent decrease of ozone may be delayed after the fall of wind speed. Numbers of maxima of wind speed and ozone in particular periods are given, and also occurrences of simple increases and decreases. The phenomenon may be related to turbulent diffusion bringing down more ozone-rich air from higher levels. J.M.Stagg

20825 ENERGY TRANSPORT DUE TO TURBULENT MIXING IN THE ATMOSPHERE.

A.J.Reynolds.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 149-54 (March, 1961).

An order-of-magnitude analysis of energy transport in a horizontally convecting turbulent atmosphere indicates that three fluxes can contribute importantly to vertical energy transfer: a heat flux due to turbulent mixing of the compressible fluid through the vertical temperature and pressure gradients; a flux of total energy produced by Archimedean forces; a work flux associated with the most important turbulent mixing stress. The relationship of these fluxes to the mean motion is discussed. It is found that the effect of the vertical pressure gradient can be represented as thermal diffusion down the potential energy gradient.

20826 ON THE EXISTENCE OF DIFFERENT STRATOSPHERIC AIR MASSES ABOVE TROPOSPHERIC JET CURRENTS.

G.Barbé.

C.R. Acad. Sci. (France), Vol. 252, No. 22, 3473-5 (May 29, 1961). In French.

Frequent soundings of wind and temperature to 30 km over Trappes on two days in October 1960 showed two air masses in the stratosphere from 10 to 30 km over a jet stream. The two masses differed in temperature by at least 4°C and the plane of transition was along the axis of the jet and nearly vertical. J.M.Stagg

20827 THE PRESSURE PULSE PRODUCED BY A LARGE EXPLOSION IN THE ATMOSPHERE.

V.H.Weston.

Canad. J. Phys., Vol. 39, No. 7, 993-1009 (July, 1961).

The pressure pulse produced by a large explosion in the atmosphere is investigated. The explosion is represented in terms of the excess pressure and normal velocity on a closed surface, outside of which the hydrodynamical equations are linearized. The pulse is represented in terms of a Fourier transform of the associated harmonic frequency problem, for which a ring-source Green's function is obtained in terms of an expansion of the discrete modes. It is shown that the excess pressure may be represented in terms of an integral (containing the Green's function) over the surface surrounding the source. The gravity wave portion of the pressure pulse at the ground is computed for various ranges from the source, which is located at various altitudes, and for three models of the atmosphere. In calculating the head of the pulse a new asymptotic technique is introduced which gives very good results for intermediate and long ranges.

20828 THE ELECTRICITY OF PRECIPITATION.

J.A.Chalmers.

Brit. J. appl. Phys., Vol. 12, No. 8, 372-6 (Aug., 1961).

Results of measurements on precipitation (rain, hail, snow) electricity are described and the problems of explaining them are discussed.

20829 WHY RAINDROPS BREAK UP — VORTEX INSTABILITY.

V.O'Brien.

J. Meteorol. (USA), Vol. 18, No. 4, 549-52 (Aug., 1961).

Experimental evidence is presented to show that the "bag-breakup" of a fluid drop falling through another immiscible fluid (e.g. a raindrop in air) is essentially the same vortex instability observed in miscible fluid vortex cascades.

20830 SIZE DISTRIBUTION OF RAINDROPS.

V.N.Kelkar.

Nature (GB), Vol. 192, 252 (Oct. 21, 1961).

The drops in 90 out of 104 monsoon rains and in 134 out of 169 thunderstorms recorded at Poona were found to have a size distribution which conforms to A.C.Best's formula $F = 1 - \exp[-(x/a)^n]$, where F(x) is the fraction of liquid water in drops of diameter less than x, and a and n are constants. The values a and n were found to be unrelated in the monsoon rain, but an = 7.1 mm in thunderstorms. J.M.Stagg

20831 THE GROWTH OF SNOW CRYSTALS AT LOW SUPERSATURATIONS.

T.Kobayashi.

Phil. Mag. (GB), Vol. 6, 1363-70 (Nov., 1961).

The result of experiments in which ice crystals are grown from the vapour at supersaturations of only a few per cent show that the c/a ratio tends towards limiting values of 1.4 for prisms and 0.8 for plates. Thus the habit of snow crystals is now clearly delineated with respect to both temperature and supersaturation or flux of vapour. The basic habit, as determined by the relative growth rates along the c and a axes, is controlled by the temperature but the secondary features of growth are governed by supersaturation as follows; in the plate regime, increasing supersaturation causes transitions from very thick plate → thick plate → sector plate → dendrite and, in the prism regime, the development is from short solid prism → longer hollow prism → needle. There now appears to be no basis for believing that the basic crystal habit is modified by changing the diffusivity of water vapour into the inert carrier gas.

20832 THE FRAGMENTATION AND ELECTRIFICATION OF FREEZING WATER DROPS.

B.J.Mason and J.Maybank.

Quart. J. Roy. Meteorol. Soc. (GB), Vol. 86, 176-85 (April, 1960).

The freezing of water drops is often accompanied by shattering of the ice shell and the production of small ice splinters. These phenomena have been studied in relation to the drop diameter in the range 30 μ to 1 mm, the nucleation temperature of the drop, the air content and purity of the water. The number of splinters produced is largely governed by the nucleation temperature (the degree of supercooling) which controls the quantity of air released during freezing and is not very dependent on drop size. Slightly supercooled drops of 1/10 to 1 mm diamater produced, on average, 20 to 50 splinters. The mechanism of drop fragmentation is discussed and the potential importance of splintering in the ice-nucleus economy of clouds is assessed. Fragmentation of freezing drops is accompanied by electrical charging, usually with the splinters positively charged and the drop residue carrying a negative charge. The magnitude of the residual charge which, on average, is observed to be about 10^{-3} e.s.u. for a millimetre drop, is related to the same factors which control splinter production. Charging by this mechanism would not appear to be of major importance in the electrification of thunderstorms.

20833 STRUCTURE OF THUNDERSTORM SHOWERS ACCORDING TO THE DATA OF THE INTENSITY DISTRIBUTION OF A RADIO ECHO WITH HEIGHT.

M.L.Markových and V.M.Muchnýk.

Ukrayin. fiz. Zh. (USSR), Vol. 5, No. 2, 259-69 (1960). In Ukrainian.

A description of the vertical cross-section of thunderstorm showers was produced with the help of a radar system with calibrated receiver. The results show that reflection is 3-5 times as great in the central parts of thunderstorm showers as it is near the ground. An attempt is made to explain the physical causes leading to such a reflection distribution with height. It is shown that evaporation of drops or their separation, which takes place with the aid of ascending currents, cannot be responsible, and that the splitting up of drops, and especially the reduction in size of melting hailstones or ice graupel when falling, is the only explanation.

20834 ELECTRIC CHARGE TRANSFER ASSOCIATED WITH TEMPERATURE GRADIENTS IN ICE.

J.Latham and B.J.Mason.

Proc. Roy. Soc. A (GB), Vol. 260, 523-36 (March 21, 1961).

The development of electric potentials in ice crystals under the influence of temperature gradients is investigated both theoretically and experimentally. The maintenance of a steady temperature gradient across a piece of ice is accompanied by concentration gradients of H^+ and OH^- ions; because of the much greater mobility of H^+ ions, these diffuse more rapidly into the colder part of the ice and, in the steady state, a potential difference is set up across th ice crystal, the colder end being positive. A theory of this effect predicts a surface density of charge on the ends of the ice of $\sigma = 5 \times 10^{-5}(dT/dx)$ e.s.u. cm^{-2} and a potential difference across a uniform specimen of about 2ΔT mV, where ΔT is the temperature difference across the ends. These values are quite well confirmed b a series of experiments on specimens of highly purified ice. When two pieces of ice of initially different temperatures are brought into temporary contact and separated, the warmer acquires a negative charge and the colder an equal positive charge. The theory indicates that a maximum charge transfer of 3×10^{-3} ΔT, e.s.u. cm^{-2} should occur with a contact time of about 0.01 s and that it should thereafter decline as the two pieces of ice become more nearly equal in temperature. The theoretical value for the charge developed for a contact time of ~0.01 s is well confirmed by experiments which also show that very little charge separation occurs if the contact period exceeds $\frac{1}{2}$ s. Experiments in which the ice was contaminated with carbon dioxide, hydrofluoric acid, and sodium chloride in concentrations of up to 50 times that normally present in rain water, showed at the electrification was not greatly influenced by these impurities. ese phenomena are throught to be of basic importance in the neration of electric charge in thunderstorms. This aspect is veloped in the following paper.

20835 GENERATION OF ELECTRIC CHARGE ASSOCIATED WITH THE FORMATION OF SOFT HAIL IN THUNDERLOUDS. J.Latham and B.J.Mason.

roc. Roy. Soc. A (GB), Vol. 260, 537-49 (March 21, 1961).

The electrical charging which results from collisions between e crystals and a simulated hailstone is measured as a function of eir temperature difference, and of the size and impact velocity of e crystals. It is found that the sign of the charging is governed by at of the temperature difference, the hailstone becoming negatively arged if it is warmer than the rebounding crystals. The magnitude the charging is proportional to the temperature difference but ther insensitive to the size and impact velocity of the crystals. ith a temperature difference of 5 deg C, a rebounding crystal of diaeter about 50μ produces, on average, a charge of 5×10^{-9} e.s.u. he electrification of an artificial pellet of soft hail growing by the ccretion of supercooled water droplets (riming) is also investigated. reezing of the droplets on the hailstone is accompanied by the jection of positively charged ice splinters, the hailstone acquiring negative charge. The manner in which the rates of charging and plinter production vary with the air temperature, drop diameter and mpact velocity has been established. In a typical experiment, with e air temperature at -15°C, droplets of diameter 80 μ impacting t 10 msec^{-1} freeze to produce, on average, 12 splinters and a harge of 4×10^{-6} e.s.u. per drop. Droplets of diameter less than 0 μ produce few splinters and little charging. The results of both ets of experiments are interpreted in terms of the author's theory f charge separation in ice under the influence of a temperature radient, and are used to calculate probable rates of charge generaion in thunderstoms. It appears that the electrification which ccompanies the growth of pellets of soft hail through the freezing nd splintering of supercooled droplets is capable of generating nd separating charge at the required rate of about 1 C km^{-3} min^{-1} ut, while rebounding ice crystals will usually charge the hailstones n the same (negative) sense, this mechanism will contribute only slightly to thunderstorm electrification.

20836 CALCULATIONS OF CLOUD ELECTRIFICATION BASED ON A GENERAL CHARGE-SEPARATION MECHANISM. J.D.Sartor.

. geophys. Res. (USA), Vol. 66, No. 3, 831-8 (March, 1961).

Using recent solutions for the electrostatic and hydrodynamic wo-body problems of the fields and forces between freely falling pheres in an electrostatic field, quantitative computations are made of the effectiveness of a general theory of cloud electrification hat considers all particles in a cloud to be polarized by the electrostatic field of the atmosphere, and rebounding encounters to result in the transfer of charge in the direction required to increase the existing fields. The calculations employing observed cloud- and rain-drop size distributions give electrostatic fields of the magnitude observed in the time required for the development of a thunderstorm.

20837 DETERMINATION OF CLOUD ALTITUDE FROM A SATELLITE. R.A.Hanel.

J. geophys. Res. (USA), Vol. 66, No. 4, 1300 (April, 1961).

Since CO_2 is uniformly distributed in the atmosphere, a comparison of the intensity of solar radiation, reflected from the upper surface of a cloud, in a CO_2 absorption band with the intensity in an atmospheric window nearby will give a measure of the amount of atmosphere above the cloud and thus of its height. Similar measurements in a water vapour absorption band will yield the total amount of water vapour above the cloud. Suitable wave lengths for absorption are given. R.S.Read

20838 AN OBSERVATION OF NOCTILUCENT CLOUDS IN WESTERN CANADA. K.D.Baker and B.W.Currie.

Canad. J. Phys., Vol. 39, No. 10, 1515 (Oct., 1961).

A few weeks after a local seminar held to discuss possible reasons why noctilucent clouds had been authentically observed in Canada only once before, this type of cloud was observed from Saskatoon in the morning of 24 July 1961. The cloud was mainly below 6° altitude and towards the sun when the latter was 6° to 11° below the horizon. This observation, made so soon after the seminar decision for an intensive search, suggests that noctilucent cloud may occur over northern Canada more frequently than reports have indicated. J.M.Stagg

20839 INFLUENCE OF AEROSOLS ON THE POLARIZATION OF SKY LIGHT. L.Foitzik and K.Lenz.

Optik (Germany), Vol. 17, No. 9-10, 554-8 (Sept.-Oct., 1960). In German.

A brief description is given of the apparatus used in Berlin to make polarization measurements. A measurement at each point of the sky takes about 15 seconds and about 50 points are used for a complete survey. The method by which the degree of polarization and the vibration direction are determined from the observations is described. Examples are given for sun altitudes of 20° and 30°. These results cannot be interpreted by the theory of scattering by air molecules but can only be explained by consideration of atmospheric aerosols. H.G.Jerrard

20840 ATMOSPHERIC EXTINCTION OF INFRA-RED RADIATION. D.Deirmendjian.

Quart. J. Roy. Meteorol. Soc. (GB), Vol. 86, 371-81 (July, 1960).

The effects of scattering on the transmission of 2.6 to 12 μ radiation are analysed as a continuation of an earlier paper [Quart. J. Roy. Meteorol. Soc. (GB), Vol. 85, 404-11 (Oct., 1960)]. Monochromatic extinction coefficients are determined on the basis of the original haze models and of the exact values of the complex index of refraction for water. The individual extinction cross-sections are computed with a high degree of accuracy by means of a modified van de Hulst expression. The results are in good agreement with existing experimental determinations of window transmission except in the 8 to 12 μ region, where they support Roach and Goody's (1958) conclusion on the importance of wing absorption by molecular lines. The computed continuous spectrum of haze extinction presented graphically and in tables, further reveals interesting details which will be useful in determining the relative importance of absorption and scattering in atmospheric infrared radiation. A simple cloud model is also considered, and it is shown that even tenuous clouds may be quite opaque to infrared radiation over a wide band. In the window regions, clouds and dense hazes scatter a considerable portion of the incident radiation, thereby contributing to the infrared sky background usually attributed to black-body emission.

20841 METHOD FOR THE COMPLETE DESCRIPTION OF INFRARED SKY BACKGROUNDS. H.G.Eldering.

J. Opt. Soc. Amer., Vol. 51, No. 12, 1424-9 (Dec., 1961).

The purpose of this paper is to define specifically the magnitude of the problem of the complete description of sky backgrounds for the optimum design of automatic detection systems. The use of joint probability densities are examined as a method for the complete description of background. The requirements for the complete description leads to an infinite dimensional analysis of background. The relationships between joint probability densities, the autocorrelation function and the Wiener spectra are explored to obtain some insight into the nature of background from measured Wiener spectra. Techniques for theoretical and experimental determination of probability of detection and probability of false alarm are considered.

TECHNIQUE FOR CALCULATING INFRARED ABSORPTANCE BY A REGULAR BAND. See Abstr. 16050

20842 PHOTOGRAMMETRIC REFRACTION ANGLE: SATELLITE VIEWED FROM EARTH. B.L.Jones.

J. geophys. Res. (USA), Vol. 66, No. 4, 1135-8 (April, 1961).

If an earth satellite is photographed from the earth against a star background for geodetic purposes, an accurate determination of the photogrammetric refraction angle ρ must be made. It is shown that ρ is very sensitive to the astronomical refraction angle R_∞ for satellite heights up to at least 10^3 km if the satellite zenith-distance is less than about 70°. For example, the error in ρ contributed by an error in R_∞ is 31 times the error in R_∞ for a satellite at a height of 200 km viewed at a zenith-distance of 10°.

20843 ADJUSTABLE POTENTIAL-GRADIENT-MEASURING APPARATUS FOR AIRPLANE USE.

B.Vonnegut, C.B.Moore and F.J.Mallahan.

J. geophys. Res. (USA), Vol. 66, No. 8, 2393-7 (Aug., 1961).

An apparatus for measuring the electrical potential gradient from aircraft by the use of radioactive, ionizing probes is described. An adjustable rotating capacitor system was devised that permits compensation for asymmetry in the exposure of the probes. While this arrangement compensates for the effects of charge on the airplane, it does not compensate for the effects of space charge produced by the airplane. It is concluded that all airplane gradient measurements in cloud or intense fields, whether made with this or any previous apparatus, are not to be trusted because of errors caused by this space charge. As the result of these errors the gradients measured in weakly electrified clouds are probably too large and the large gradients measured near thunderstorms are probably too small. Examples of gradient records obtained with this apparatus near a source of artificially produced space charge are presented.

20844 THE ELECTRIC FIELD OF A LARGE DUST DEVIL.

G.D.Freier.

J. geophys. Res. (USA), Vol. 65, No. 10, 3504 (Oct., 1960).

An electric-field mill recording of the electric field of a dust devil at a distance of 30 m shows that the field swings negatively and positively 430 V/m and 300 V/m respectively from the steady value of 150 V/m. It is suggested that an electric dipole of moment 1.7×10^9 e.s.u. cm at a height of 21.4 m will explain the main features of the recording, although the required velocity in then too low by a factor of 25. D.Llanwyn-Jones

20845 TECHNIQUE FOR INTRODUCING LOW-DENSITY SPACE CHARGE INTO THE ATMOSPHERE.

B.Vonnegut, K.Maynard, W.G.Sykes and C.B.Moore.

J. geophys. Res. (USA), Vol. 66, No. 3, 823-30 (March, 1961).

A technique for modifying the natural fairweather electric field over large areas by the introduction of artifically produced space charge is described. The apparatus consists of a fine horizontal wire supported on insulators are maintained at a high voltage by a d.c. power supply. With a 0.013 cm diameter wire 4.5 m long and 4 km high maintained at 12 kV of negative polarity a corona current of about 1 mA flows, and the normal fair-weather electric field is reversed for a distance of 10 km or more downwind. The experimental observations are in fair agreement with a simple theory.

20846 AURORAL EFFECTS ON THE EARTH'S ELECTRIC FIELD.

G.D.Freier.

J. geophys. Res. (USA), Vol. 66, No. 9, 2695-2702 (Sept., 1961).

On three occasions of auroral appearance near the latitude of Minneapolis (October 7, November 13, and December 1, 1960), measurements of the earth's electric field and time constants of the atmosphere showed abnormal conduction currents at the surface of the earth corresponding to 10^4 electrons cm^{-2} sec^{-1}. A theoretical formulation of fair-weather electric field phenomena is given, and the measurements are interpreted in terms of this theory to show how measurements on the ground are related in general to current generators in the atmosphere.

20847 THE COMPENSATION OF THE EFFECTS OF POTENTIAL-GRADIENT VARIATIONS IN THE MEASUREMENT OF THE ATMOSPHERIC AIR—EARTH CURRENT.

J.Adamson.

Quart. J. Roy. Meteorol. Soc. (GB), Vol. 86, 252-8 (April. 1961).

A well-known method of determining the atmospheric air—earth current consists of collecting and measuring the current flowing into an insulated receiver at ground level. A difficulty encountered, however, is that any variation of the potential gradient produces a displacement of the bound charge on the collector, leading to a spurious "displacement" current. In the simplest form of the method, this current can occasionally be so large as to mask completely the true-earth current. This article describes a development in which the sum of the air—earth and displacement currents is measured at one terminal of a differential amplifier, while a field machine provides automatic and continuous compensation for the displacement current at the other terminal. The apparatus thus enables a continuous true recording of the air—earth current to be made, and is an improvement on previous methods of eliminating the displacement current which necessitated intermittent recording of the integrated charge collected over a period of time. Satisfactory results are obtained with this method in all weather conditions except thunderstorms.

20848 A STUDY OF IONOSPHERICS AT MACQUARIE ISLAND.

B.A.McInnes.

Austral. J. Phys., Vol. 14, No. 2, 218-33 (June, 1961).

Very-low-frequency radio emissions of natural origin, sometimes known as ionospherics, recorded at Macquarie Island were examined and grouped into classes. The diurnal variations of all classes show a non-uniform distribution with a peak shortly before local midday. The ionospherics appeared to fall into three groups as regards dependence on magnetic K-index. Strong correlations were discovered between values of emission frequency and K-index for several classes of ionospherics. The role of Cherenkov radiation in the generation of ionospherics is discussed. Suggested energy distributions are put forward to explain various classes of ionospherics. The magnetic associations and diurnal variation are explained on the basis of current geomagnetic disturbance theo Ionospheric absorption is also considered to affect the diurnal variation. The phenomenon of "surf", as reported by Campbell and Pope (Abstr. 1517 of 1961) is discussed.

20849 METHOD OF DEDUCING THE LINE OF MAGNETIC FORCE TAKEN BY A WHISTLER.

C.Renard.

C.R. Acad. Sci. (France), Vol. 252, No. 20, 3096-8 (May 15, 1961). In French.

Expressions are derived for the dispersion constants D_0 and D of the whistler dispersion formula

$$tf^{1/2} = D_0 + D_1f + D_2f^2$$

from the known line integral expressions of these two constants, in terms of the geomagnetic latitude L, gyrofrequency at the geomagnetic equator f_e, and the factor $K = N/f_H$ where N is the electron density at the point on the line of force where the gyrofrequency is f_H. The quotient D_0/D_1 involves only f_e and the geomagnetic latitude, L_0, of the foot of the line of force. By measuring D_0/D_1 L_0 may be calculated. The expression for D_0 may be written as $D_0 = A(x_0)K^{1/2}$ where $x_0 = \sin L_0$. Values of $A(x_0)$ are tabulated togethe with value of $(D_1/D_0)(x_0)$. By this means the value of K for Kerguel may be found at any time. A value of $K = 10^{-2}$ electron $cm^{-3}(c/s^{-1})$ was obtained on a particular occasion from analysis of a "short"-type whistler. The same value was obtained from analysis of a second (weaker) whistler initiated at a different geomagnetic latitude. This value of K gives a value for N comparable to that found by other observers and the method also shows the validity of the assumed electron profile. D.Llanwyn-Jone

20850 THE DETERMINATION OF THE DIRECTION OF ARRIVAL AND THE POLARIZATION OF WHISTLING ATMOSPHERICS. I. EXPERIMENTAL APPARATUS.

J.Delloue.

J. Phys. Radium (France), Vol. 21, No. 6, 514-26 (June, 1960). In French.

The explanations put forward are based upon the magneto-ionic theory and suggest a particular mode of propagation of very low frequency electromagnetic waves along the lines of force of the earth's magnetic field through the feebly ionized regions of the outer atmosphere (L.R.O.Storey: Abstr. 8135 of 1953). As a checl to this theory, the directions of arrival of whistlers, which should make a rather small angle with the direction of the magnetic field, and their polarization, which is related through a magneto-ionic formula to that angle, were determined. The directions of arrival were determined by measuring the time lag between the signals induced by whistlers in two pairs of identical aerials located at the ends of two perpendicular bases. Microwave radio links were usec to re-transmit the induced signals. The "projected" polarization was obtained from two vertical crossed loops, and the plane wave polarization can be deduced from the direction of arrival. Various considerations are given which led to the choice of a selective apparatus, such that time lag measurements are ordinary phase lag measurements. A frequency of 5.5 kc/s was selected because the amplitude of whistlers is large for most of the time in that part of the spectrum, while the level of long distance atmospherics is low. The signals induced in the aerials were fed to high gain, wide band low noise amplifiers with stable and identical characteristics, and after re-transmission over radio links, to selective amplifiers wit identical phase characteristics and a bandwidth adjusted to obtain the best response to the frequency variation most often observed. The voltages corresponding to the crossed loops were then applied to a "polarization" oscilloscope. The signal corresponding to the ends of each base were fed to a phase comparer which displayed the instantaneous phase lag on an oscilloscope as a straight or slightly elliptic slope. A continous slow speed camera photographed simultaneously the polarization oscilloscope and the two phase-oscilloscopes, to which convenient blanking voltages were applied. Fields tests of the equipment led to successive alteration Phase correcting networks were introduced and the "polarization" section of the equipment had to be separated from the "directions of arrival" section.

20851 THE DETERMINATION OF THE DIRECTION OF ARRIVAL AND THE POLARIZATION OF WHISTLING MOSPHERICS. II. RESULTS. J.Delloue.
Phys. Radium (France), Vol. 21, No. 7, 587-99 (June, 1960).
French.

The interpretation of the patterns recorded is discussed. A mple way of representing the directions of arrival is proposed d the rules which are to be observed to obtain usable phase terns are explained. A study of the polarization of whistlers ows that, provided a few simplifying assumptions are made, the erage conditions along the trajectory of a whistle can be presented by a single parameter τ which, along with the angle tween the direction of arrival and the magnetic field, determines polarization ellipse in the wavefront. The polarization observed pends then on the direction of arrival and can be deduced from the evious one by a cylindrical projection. Polarization diagrams are only convenient way of solving the inverse problem and to deter- ne the parameter τ. Measurements show that the direction of rival rotates around the magnetic field and makes a rather small gle, between 5 and 28°, with that direction. No angle smaller than was observed. The projected polarization depends on the direction arrival as well as on the conditions encountered along the ojection path. The results are consistent with the directions of rival observed, and lead to electron densities smaller than those oted by Storey. The occurrence of sequences of several strong istlers with the same polarization and phase characteristics thin the same sequence could be explained in terms of the sudden pearance in the outer atmosphere of ionized centres with the ort lifetime of about a few minutes.

20852 ON THE EXTREMELY LOW FREQUENCY SPECTRUM OF EARTH—IONOSPHERE CAVITY RESPONSE TO ECTRICAL STORMS. H.R.Raemer.
geophys. Res. (USA), Vol. 66, No. 5, 1580-3 (May, 1961).

The spectrum of atmospheric noise in the range 4-40 c/s is lculated from statistical data on lightning flashes and the sponse function of the earth—ionosphere cavity. Comparison with perimental data gives the frequency dependence of the "ionospheric s parameter". H.Rishbeth

20853 SIMULTANEOUS OBSERVATIONS OF V.L.F. NOISE ("HISS") AT HOBART AND MACQUARIE ISLAND.
L.Dowden.
geophys. Res. (USA), Vol. 66, No. 5, 1587-8 (May, 1961).

Observations of bursts of noise were made on frequencies of 3 and 9.3 kc/s early in 1960. The author draws some rather neral conclusions about the geographic location of the virtual urces of the bursts. D.M.Schlapp

20854 TWO-HOP 18.6 kc/s WHISTLER-MODE ECHOES RECEIVED AT SEATTLE. H.R.Willard.
geophys. Res. (USA), Vol. 66, No. 6, 1976-7 (June, 1961).

Echoes of pulsed transmissions at 18.6 kc/s from a US Naval ation received at Seattle during night hours show time-delays of 0.7 to 1.7 sec. The echoes are characterized by rapid fluctuation amplitude, suggesting interference between signals propagated er paths with slightly different times. There existed a weak rrelation between echo reception and enhanced geomagnetic tivity, but this was not invariably so. D.R.Barber

20855 EXTENSION OF NOSE WHISTLER ANALYSIS.
R.L.Smith and D.L.Carpenter.
geophys. Res. (USA), Vol. 66, No. 8, 2582-6 (Aug., 1961).

Methods are given for finding the nose frequency and time lay for ordinary whistlers in which the "nose" is not observed. ith well-defined and well-calibrated spectrograph traces it is ssible to obtain statistically reliable nose frequencies as high as kc/s. This allows information on whistler path location and ectron density to be obtained from ordinary whistlers and not lely from the rarer nose whistlers. The method was applied to tual nose whistler traces to test the accuracy of the method.
D.M.Gilbey

20856 TRANSRESONANT ELECTRON ACCELERATION.
E.N.Parker.
geophys. Res. (USA), Vol. 66, No. 9, 2673-6 (Sept., 1961).

Helliwell and Bell (Abstr. 18486 of 1960) have suggested ynchronous acceleration of electrons by electromagnetic waves n the whistler range in the geomagnetic field. The acceleration f trapped electrons by electromagnetic waves is here generalized to include nonsynchronous or transresonant acceleration. It is shown that whistlers will scatter the electron velocity, by an amount inversely proportional to the square root of the time rate of change of the whistler frequency, during the time that the whistler frequency is passing over the electron gyrofrequency. Only electrons with initial energy above about 10^2 eV can experence the Doppler-shifted whistler frequency at the gyrofrequency and be affected by this transresonant acceleration. Thermal electrons experience no effect. Current observation of whistlers in the outer geomagnetic field is too sketchy to allow a determination of transresonant acceleration rates, so that the relative importance, as compared, for example, with the strong-whistler synchronous acceleration of Helliwell and Bell, cannot be assessed. The importance of whistler acceleration can be established when the whistler frequency spectrum and recurrence rate are known throughout the geomagnetic field.

20857 THE EFFECT OF PROTON GYRATION IN THE OUTER ATMOSPHERE REPRESENTED ON THE DISPERSION CURVE OF WHISTLER. T.Ondoh and S.Hashizume.
J. Geomagn. Geoelect. (Japan), Vol. 12, No. 1, 32-7 (1960).

The complete dispersion curve for the purest short whistler observed at Kyoto during 1958 was compared with that derived from Storey's theory with corrections at high and low audio frequencies for the effects of electron and proton gyration respectively. The influence of proton gyration is expected to be greatest where the proton gyrofrequency is greatest, i.e. at low-latitude stations where the whistler paths are confined to low heights. The effect of proton gyration is clearly revealed in the results for Kyoto, which has a low geomagnetic latitude. G.M.Brown

20858 GUIDING OF WHISTLERS IN A HOMOGENEOUS MEDIUM. R.L.Smith.
J. Res. Nat. Bur. Stand. (USA), Vol. 64D, No. 5, 505-8 (Sept.-Oct., 1960).

The velocity of energy flow of whistlers in a homogeneous medium is computed as a function of wave-normal angles. The maximum allowable cone of ray angles approaches 19°29' at very low frequencies, decreases with frequency to a minimim of 11° at a wave frequency of one-fifth the gyrofrequency, then increases to 90° at the gyrofrequency. The velocity of energy flow departs markedly from the longitudinal value except at very low frequencies or very small wave-normal angles.

20859 DISPERSIONS OF MULTIPLE-STROKE WHISTLERS. N.D.Clarence and P.A.O'Brien.
Nature (GB), Vol. 190, 1096-7 (June 17, 1961).

For whistlers recorded at Durban during the I.G.Y., the dispersion was found to increase by an average of 5% between successive strokes. H.Rishbeth

20860 ENERGY SPECTRUM OF ATMOSPHERICS AND ATTENUATION OF DIFFERENT LOW FREQUENCIES WITH DISTANCE. S.R.Khastgir and R.S.Srivastava.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. Suppl. 2, 58-66 (Dec., 1960).

Experiments were carried out to study the energy spectrum of different atmospherics and the attenuation of different frequencies (3-15 kc/s) over widely varying distances (150-1500 km) during the night hours. The method and experimental procedure are described. Considering only those atmospherics which gave smooth and continuous amplitude variations in the narrow-band amplifiers, and which showed at the same time return stroke pulses with successive ionospheric reflections in the automatic atmospherics recorder, the energy spectrum curves were drawn for the individual atmospherics originating at various distances, which were estimated from the time-intervals between successive ionospheric reflections in the wave-form records. The frequency for which the maximum amplitude was observed was found to increase almost linearly with distance. The attenuation curves were also drawn for 6, 7, 8, 9 and 10 kc/s relative to 12 kc/s over a distance ranging from 150 to 1500 km. The curves are not very different from Budden's theoretical curves.

20861 A CRITERION FOR THUNDERSTORM THEORIES. J.A.Chalmers.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 174-6 (June, 1961).

It is shown that thunderstorm theories of the classical type would predict a charging current greater than the external currents, but the reverse is true for theories of the convection type. Such results as are available favour the classical type of theory, but more measurements are required.

20862 RADIO-METEOROLOGICAL STUDY OF THUNDERSTORMS ON 85 kc/s BAND IN THE TROPICS.

M.W.Chiplonkar, R.N.Karekar and P.R.Marwadi.

J. sci. industr. Res. (India), Vol. 20B, No. 6, 238-43 (June, 1961).

The results of a statistical analysis of the records of the radio-meteorological thunderstorms observed at Poona during the period 1957-58 are presented. The results indicate that there is a significant difference between the radio-meteorological characters of thunderstorms before and after July. Further, the rate activity is observed to precede the intensity activity, particularly in the pre-July season; this observation may have some significance in weather forecasting.

20863 NARROW-BAND ATMOSPHERICS FROM TWO LOCAL THUNDERSTORMS. F.Horner.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 1, 13-25 (April, 1961).

Atmospherics from two local storms at known distances were recorded on magnetic tape. The frequencies of reception were 11 Mc/s for one storm and both 6 kc/s and 11 Mc/s for the other. The power bandwidths were in the range 200-300 c/s. Values of duration, peak amplitude, mean field strength and mean power flux have been deduced from the records, and estimates of the radiated power were derived. The waveforms of the atmospherics are partly explicable in terms of known characteristics of lightning discharges, but there are many features, particularly at 11 Mc/s, for which an adequate quantitative explanation is lacking. The results conflict with some theories of the origin of high-frequency atmospheric noise which have been advanced in recent years.

20864 E.L.F. ELECTRIC FIELDS FROM THUNDERSTORMS. A.D.Watt.

J. Res. Nat. Bur. Stand. (USA), Vol. 64D, No. 5, 425-33 (Sept.-Oct., 1960).

The varying electromagnetic fields produced by thunderstorms and associated lightning discharges are examined. Calculated field variations produced by an assumed typical cloud-to-ground discharge model are found to agree well with observed fields. The magnitude of these vertical electric field changes are observed to decrease very slowly with distance from the source for values comparable to discharge channel heights. From 4 to 20 km a $1/d^3$ relation is observed, and beyond 30 km the field variations appear to follow a 1/d relation. The expected radiation field frequency spectra from 1 c/s to 100 kc/s are calculated employing models assumed to be typical of "long" and "short" discharges. The radiation spectra obtained from 1 to 100 kc/s for observed cloud-to-ground discharge field variations normalized to 1 km are seen to agree within expected limits with calculated values. The models employed indicate that below 300 c/s "long" discharges produce much more energy than "short" discharges, and that inter-and intra-cloud discharges may produce as much energy as cloud-to-ground discharges. Anticipated variations of total vertical electric field frequency spectra as a function of distance, based on the work of Wait, are shown for the frequency range from 1 c/s to 100 kc/s.

20865 THE OPTICAL SPECTRUM OF LIGHTNING.

L.E.Salanave.

Science (USA), Vol. 134, 1395-9 (Nov. 3, 1961).

Reviews the present knowledge of the subject and considers applications in the study of cloud physics.

20866 THE TEMPERATURE OF LIGHTNING AND FORCE OF THUNDER. Yu.N.Zhivlyuk and S.L.Mandel'shtam.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 483-7 (Feb., 1961). In Russian.

The temperature in the lightning channel was measured by a spectroscopic method with the help of the N II and O II lines and a value $T \sim 20\,000^\circ$ was obtained. This value is in good agreement with the results of a calculation based on the hydrodynamic theory of development of the spark channel. The hydrodynamic model was further used to calculate the force of the thunder, i.e. the pressure on the front of the shock wave. Excess pressures are obtained which in a number of cases may lead to destruction of objects located a few metres from the lightning. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 338-40 (Aug., 1961)].

ON THE THEORY OF AMPLITUDE DISTRIBUTION OF IMPULSIVE RANDOM NOISE AND ITS APPLICATION TO THE ATMOSPHERIC NOISE. See Abstr. 15395

20867 SOME AIRBORNE REFRACTIVE-INDEX MEASUREMENTS AT 150 mb.

P.E.Sherr.

J. Meteorol. (USA), Vol. 18, No. 4, 494-500 (Aug., 1961).

Index of refraction data obtained by a Crain microwave refractometer mounted in an aircraft on two flights during August 1959 are presented. Emphasis is placed on the horizontal portions of the flights at the 150 mb level, but climbout and descent data are also given. Comparisons are made with theoretical data and index data computed from radiosondes. Some conclusions are drawn about the variability of the index of refraction in the lower stratosphere.

20868 ATMOSPHERIC NOISE LEVELS FROM 0.6 TO 10 KILOCYCLES PER SECOND.

L.H.Ginsberg and D.J.Blattner.

J. geophys. Res. (USA), Vol. 66, No. 6, 1745-9 (June, 1961).

A total of 9600 observations of atmospheric noise in the frequency range 0.6 to 10 kc/s at Point Arguello, California, and Perrine, Florida, during April-July 1960 are reported. The data are plotted to show spectral distribution and diurnal variations. The minimum noise levels occurred between 3 and 5 kc/s. This result is in agreement with the waveguide theory of Wait [Abstr. 5192 B of 1957; Proc. Inst. Radio Engrs (USA), Vol. 45, No. 6, 768-71 (June, 1957)] and with measurements by Watt and Maxwell (1957) and Taylor (1960).

20869 MICROWAVE ABSORPTION IN THE EARTH'S ATMOSPHERE. S.N.Ghosh and V.Malaviya.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 4, 243-56 (July, 1961).

The microwave absorption was calculated for different layers of the earth's atmosphere around peak resonance frequencies for each constituent gas. The total absorption for the whole atmosphere is then obtained. For such calculations, it is necessary to know the peak absorption at the centre of the absorption line and its half-width. It was shown that for atmospheric gases the peak absorption is pressure-independent and that it varies as $(3 - x)$-th power of absolute temperature for diatomic (O_2) and linear polyatomic (N_2O) molecules and as $(7/2 - x)$-th power of absolute temperature for symmetric (H_2O) and asymmetric top (O_3) molecules. The half-widths of the absorption lines were calculated after assuming the temperature from ARDC Model Atmosphere and the vertical distribution of atmospheric constituents as given by Miller (Abstr. 5532 of 1958). Three sets of curves are also presented whereby the amount of absorption at an operating frequency can be calculated for different atmospheric layers.

20870 METHODS OF PREDICTING THE ATMOSPHERIC BENDING OF RADIO RAYS.

B.R.Bean, G.D.Thayer and B.A.Cahoon.

J. Res. Nat. Bur. Stand. (USA), Vol. 64D, No. 5, 487-92 (Sept.-Oct., 1960).

Three methods for predicting the bending of radio rays when th refractive index profile above the surface layer is unknown have be developed recently by the authors. These methods are: a statistica technique for refraction at high initial elevation angles, estimation bending from an exponential model of atmospheric refractive index, and a modification of the exponential model to account for the heavi weighted effect of anomalous initial refractive index gradients at small initial elevation angles. Each model is dependent upon the value of the refractive index at ground level or, in the case of super refraction, the additional knowledge of the refractive index gradient next to the earth's surface. Each method works best in a particular range of initial elevation angles or meteorological conditions. The height and angular ranges of application of each method are checke by comparison with values obtained from 77 diverse refractive inde profiles representative of wide climatic variation. It is found that the use of the best of the three methods will always result in a prediction of the total atmospheric bending within 10% for initial elevation angles from zero to 10 mrad and to within 4% for initial elevation angles greater than 17 mrad (~ 1 deg).

20871 THE INFLUENCE OF TROPOSPHERIC JET CURRENT ON THE FALLOUT OF RADIOACTIVE PARTICLES AND A POSSIBLE MECHANISM FOR THE VERTICAL TRANSFER OF STRATOSPHERIC AIR. G.Barbé.

C.R. Acad. Sci. (France), Vol. 252, No. 23, 3620-2 (June 5, 1961). In French.

To account for some of the main facts of radioactive fallout summarized in the paper (e.g. that fallout takes place predominant leward of the locality of injection, and that it is earlier when the jection has been into the stratosphere over middle or high latitudes an when it has been over equatorial regions) a sketch diagram is ven to show the probable vertical circulation in the atmosphere ound a jet stream. The diagram is based on existing observations, e author's and others. The circulation has two cells, one over the her. The stratospheric cell with its lower limb just above the vel of the jet core has descending air on the cold side of the jet nd ascending on the warm side. The tropospheric cell has its oper limb through the core and, like the upper cell circulates ounter-clockwise from the end-on view of the jet. With the sub-opical jet extending from 15° to 40° in latitude over Africa, the aximum fallout would be around 40° as has been found in recent ears. The position of the polar jet is more variable but by the ame mechanism the minimum of fall-out would be around 45°-50° nd the maximum north of that latitude. J.M.Stagg

20872 A THEORY FOR CLOSE-IN FALLOUT FROM LAND-SURFACE NUCLEAR BURSTS. A.D.Anderson.
. Meteorol. (USA), Vol. 18, No. 4, 431-42 (Aug., 1961).

Current fallout-computation methods do not account for the arly-time dynamics of the fallout process. Therefore, the present eory was originated in the attempt to explain the mechanics of fall-ut more completely. This theory is checked by developing from it a athematical fallout model for land-surface bursts (the D model) and hen by using this model to predict fallout properties for nuclear ests. From a comparison of the predictions with observed test ata, it is concluded that the new theory, despite certain idealiza-ions, is useful for fallout computation.

20873 ORIGIN OF RADIOACTIVE FALLOUT IN THE NORTHERN HEMISPHERE AFTER THE SPRING MAXIMUM IN 959. J.F.Bleichrodt, J.Blok and E.R.van Abkoude.
. geophys. Res. (USA), Vol. 66, No. 7, 2183-7 (July, 1961).

Evidence is presented that an insignificant fraction of debris rom the Soviet nuclear test explosions in October 1958 was present n the lower stratosphere at the end of 1959 and that fallout during 960 mainly originated from injections into the tropical stratosphere during 1958.

20874 MEASUREMENT OF THE Kr^{85} CONTENT OF THE AIR. O.Griesser and A.Sittkus.
Z. Naturforsch. (Germany), Vol. 16a, No. 6, 620-1 (June, 1961). In German.

During 1959 and 1960 seven samples of atmospheric krypton were examined for their content of radioactivity. The Kr^{85} content increased from the middle of 1959 to the end of 1960 from 3.3 to 4.5 $\times 10^{-12}$ Curie cm^{-3} Kr. This corresponds to a Kr^{85} activity of the atmosphere of 3.8 and 5.1 $\times 10^{-18}$ Curie cm^{-3} air respectively. These data are discussed in connection with the production of the isotope by nuclear fission. It is shown that the main part presumably originates from reactor stations.

GAMMA-ACTIVE FALL-OUT IN ONTARIO 1958-60.
See Abstr. 17007

20875 ALLOWANCE FOR WIND TURBULENCE IN THE CALCULATION OF SOUND SCATTERING IN THE ATMOSPHERE. M.A.Kallistratova and V.I.Tatarskii.
Akust. Zh. (USSR), Vol. 6, No. 4, 503-5 (1960). In Russian.
English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 4, 503-5 (April-June, 1961).

20876 TURBULENT DIFFUSION OF INDUSTRIAL CONTAMINATION IN THE ATMOSPHERE. F.H.Schmidt.
Ned. Tijdschrift Natuurkde (Netherlands), Vol. 26, No. 10, 305-16 (Oct., 1960). In Dutch.

The dispersal of contamination such as smoke from stacks is reviewed. A theory is developed based on the work of Sutton for dealing with the case of a continuous point source under various atmospheric conditions. W.Steckelmacher

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UPPER ATMOSPHERE
IONOSPHERE

(See also Space Research. Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

20877 MATERIALS OF COMPLEX GEOPHYSICAL OBSERVATIONS IN YAKUTSK FOR JULY 1959.
A.I.Kuzmin, G.V.Shaffer, Y.G.Shaffer, D.D.Krasilnikov, G.F.Krimsky, A.P.Mamrukov, N.S.Smirnov and V.I.Yarin.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p.44-50.

A description is given of the instrumentation and lay-out of the Yakutsk, USSR, geophysical research centre. The geomagnetic, ionospheric, auroral, and cosmic-ray data obtained during the July 1959 events are described and interpreted. D.R.Barber

20878 SOLAR X-RAYS.
R.W.Kreplin.
Ann. Geophys. (France), Vol. 17, No. 2, 151-61 (1961).

Over the past eleven years and especially during the I.G.Y. and I.G.C. the U.S. Naval Research Laboratory conducted rocket borne experiments in which solar X-ray radiation was measured both during quiet periods and periods of intense solar activity. These measurements were made using ion chamber, photon counter, and scintillation counter techniques and covered the wavelength ranges 2-8 A, 8-20 A, 44-60 A, 2-20 keV, and 20-200 keV. The results of these measurements have shown increases of X-ray radiation from sunspot minimum to sunspot maximum which correlate with the increase of E-region critical frequencies and with coronal green line intensities over the same period. Measurements made during solar flares have shown large increases in X-ray flux as well as a "hardening" of the X-ray spectrum at these times. The solar eclipse experiment of 12 October 1958 helped to isolate the sources of X-rays on the solar disc and also showed that the residual coronal emission could account for the presence of E-region ionization during totality. An X-ray picture of the sun made with a pin-hole camera in 1960 showed a close correlation with the calcium K line plage pictures made on the same day. These two experiments revealed that most of the solar X-ray radiation came from active regions rather than from a uniform corona.

20879 CHEMICAL EXPLOSION IN THE HIGH ATMOSPHERE.
J.E.Blamont, J.Hiéblot and E.Selzer.
C.R. Acad. Sci. (France), Vol. 252, No. 21, 3317-18 (May 24, 1961). In French.

Some preliminary results are presented of the Veronique rocket explosion at 157 km over Algeria on 18 June 1960. The main object of the explosion was to study the shock waves produced in the high atmosphere but a sodium cloud was also produced from 143 km upwards on the ascent. The results are grouped under the headings: optical, acoustic and magnetic. J.M.Stagg

20880 ANALYSIS OF SATELLITE DATA.
D.G.Parkyn.
Nature (GB), Vol. 191, 896-7 (Aug. 26, 1961).

The author's method of analysis of orbital data (Abstr. 73, 9168 of 1959) is used to determine atmospheric scale height at altitudes near 200 km. The existence of an 8-hourly tidal component is suggested. H.Rishbeth

20881 DENSITY OF THE UPPER ATMOSPHERE DETERMINED FROM SATELLITE ORBITS, AND ITS VARIATION DURING 1957-61.
D.G.King-Hele and D.M.C.Walker.
Nature (GB), Vol. 191, 114-18 (July 8, 1961).

A summary is given of results obtained from an improved method of calculating air density from the integrated effect of air drag on the orbital period of 29 satellites. The density is only about 10% greater by day than night at heights of 200-300 km., but at 600 km the daytime maximum density is 5-10 times greater than the night-time minimum. No significant variation of density with latitude is found. A general decrease in density with falling solar activity between 1958 and 1960 is revealed, the magnitude of the change increasing with height in the range 180-700 km. G.M.Brown

20882 ATMOSPHERIC DENSITIES AT HEIGHTS OF 180-700 km.

D.G.King-Hele and D.M.C.Walker.

Ann. Phys. (France), Vol. 17, No. 2, 162-71 (1961).

Densities at heights between 180 and 700 km are determined from the changes in the orbits of the 22 satellites which are suitable for this purpose. It is shown that 8 satellites with perigee heights above 360 km all clearly reveal a large variation of density between day and night: the maximum day-time density exceeds the minimum night-time value by a factor which rises from about 1.5 at 400 km height to between 6 and 10 at 600 km. It is also found that there has been a decrease in density between 1958 and 1960, in accordance with the decrease in solar activity, and that the night-time temperature is nearly constant, at roughly 1000°K, at heights between 300 and 700 km.

20883 SUGGESTION OF A SECOND ISOPYCNIC LEVEL AT 80 TO 90 KILOMETERS OVER CHURCHILL, CANADA.

A.E.Cole.

J. geophys. Res. (USA), Vol. 66, No. 9, 2773-8 (Sept., 1961).

All available observations from rocket-borne instrumentation (falling spheres, grenades, pressure gauges, etc.) were used to examine the distribution of atmospheric density over Churchill, Canada. An observed reduction in seasonal and interdiurnal variability between 80 and 90 km strongly suggests the presence of a second isopycnic level in this region. Daily and seasonal density profiles appear to converge and cross at this altitude.

20884 DETERMINATION OF ATMOSPHERIC DENSITIES FROM SATELLITE OBSERVATIONS.

C.A.Whitney.

Ann. Geophys. (France), Vol. 17, No. 2, 237-44 (1961).

Factors affecting the derivation of atmospheric densities from the decay of satellite orbits are discussed. Orbital perturbations produced by departures of the earth's gravitational field from a Newtonian field are outlined. It is stated that uncertainties of the orbital geometry introduce only trivial errors into the density derivation. Major errors may be produced by uncertainties of satellite geometry and evaluation of the efficiency of momentum transfer between the atmosphere and the satellite. By careful attention to available data, the geometrical uncertainties can be reduced to 10%-20% even for thin cylindrical satellites. At elevations greater than 200 km present estimates of the efficiency of momentum transfer may be correct within 25%; at lower elevations the error may be as great as 50%. The spatial resolving-power of derived densities is fairly low, amounting to some 60° along the orbit. The temporal resolving power can be as low as a third of a day in favourable cases but is typically one or two days.

20885 DAYTIME AND NIGHTTIME ATMOSPHERIC PROPERTIES DERIVED FROM ROCKET AND SATELLITE OBSERVATIONS.

H.K.Kallmann-Bijl.

J. geophys. Res. (USA), Vol. 66, No. 3, 787-95 (March, 1961).

Upper air densities obtained by means of rockets and satellites in the region from 100 to 800 km are presented. Variations of densities from day to night become apparent around 200 ± 30 km; the effect increases with altitude. Pressures and scale heights are derived from densities, and preliminary mean, and daytime and night-time values are obtained. From the variation of scale height with altitude, regions of constant temperature and of variable molecular weight are determined. It is found that the mean temperature at about 300 km is approximately 1400°K, and that it stays constant above the altitude. Two hours after noon, at about 350 km, the temperature rises to approximately 1800°K. Shortly after midnight, the temperature drops to about 1050°K and stays approximately constant above 250 km. A change in slope of the density curve in the ionosphere is indicated from satellite observations. It is shown that, as a result of this, the scale height in the F and E regions has a pattern comparable to the electron density pattern in these regions. The possibility of a solar activity effect on densities is discussed.

20886 AIR DENSITY VARIATIONS IN THE MESOSPHERE AND THE WINTER ANOMALY IN IONOSPHERIC ABSORPTION.

J.Mawdsley.

J. geophys. Res. (USA), Vol. 66, No. 4, 1298-9 (April, 1961).

It is suggested that the anomalous winter daytime absorption of radio waves may be related to the large mesospheric air density variations recently reported to exist at high latitudes in winter. Speculations as to the mechanism of the coupling between the two phenomena are presented. In particular it is suggested that the air density fluctuations may cause enhancement of nitric oxide density thus giving rise to the absorption. In order to demonstrate the coupling, simultaneous observations of the air density and ionospheric absorption at a high latitude station are required.

D.Llanwyn-Jones

20887 SEASONAL AND LATITUDINAL VARIATIONS OF AIR DENSITY IN THE MESOSPHERE (30 to 80 KILOMETERS).

R.S.Quiroz.

J. geophys. Res. (USA), Vol. 66, No. 7, 2129-39 (July, 1961).

Thd detailed density data for 69 soundings of the mesosphere are analysed statistically. The soundings, obtained at latitudes from the equator to 75°N during 1947-1958, were taken by four methods of observation — rocket with pressure gauges, rocket grenade, rocket and falling sphere, and the searchlight technique. Mean and extreme densities for the summer and winter half-years are presented for three latitude bands, for every 2 km from 30 to 80 km, along with means and extremes for the entire data sample. Standard deviations of density are given for every 10 km. A tentative model of the seasonal variation of density from near the ground to a height of 200 km is included. Various aspects of the variability of density in the mesosphere are discussed, with special emphasis on the large seasonal variation in northerly latitudes, especially at altitudes of around 60 to 70 km.

20888 WIND AND TEMPERATURE MEASUREMENTS IN THE MESOSPHERE BY METEOROLOGICAL ROCKETS.

J.E.Masterson, W.E.Hubert and T.R.Carr.

J. geophys. Res. (USA), Vol. 66, No. 7, 2141-51 (July, 1961).

Small, solid-propellant rockets carrying meteorological instruments to altitudes beyond the capability of conventional balloons provided a relatively large number of direct measurements of wind and temperature in the mesosphere. Data are presented from 110 meteorological-rocket launches made at Point Mugu, California, during a 17-month period. They show (a) strong reversal in the mesospheric zonal flow from winter to summer; (b) temporary breakdown in the winter westerlies in late January; (c) reversal in the meridional flow between 40 000 and 70 000 feet from winter to summer; (d) at least three meridional circulation cells in the vertical; (e) large temperature fluctuations in the mesosphere but good correlation, in the mean, with the ARDC Model Atmosphere.

20889 FRICTIONAL EFFECTS AND THE MERIDIONAL CIRCULATION IN THE MESOSPHERE.

B.Haurwitz.

J. geophys. Res. (USA), Vol. 66, No. 8, 2381-91 (Aug., 1961).

The observed warm winter temperatures in the upper mesosphere at high latitudes, where no direct heating by solar radiation takes place, require vertical descent of air from the lower ionosphere into the upper mesosphere. Such descent leads to adiabatic heating and to stronger heating because of the recombination of oxygen atoms into oxygen molecules. It is shown that the curvature of the vertical profile of the mean zonal wind component results in frictional meridional components of motion of the right direction and of a reasonable order of magnitude to produce the divergence required for such a descent of the air into the high mesosphere over the subpolar regions during the winter season. A more detailed computation of the frictional meridional wind components gives meridional-circulation systems similar also to those required for an explanation of the maximum of the total ozone content at high latitudes in late winter or early spring.

20890 RATE OF ION—ATOM INTERCHANGE.

D.R.Bates and M.Nicolet.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 4, 286-7 (July, 1961).

The conversion of other positive ions into NO^+ is effectively irreversible under upper atmospheric conditions. If such processes were fast, NO^+ would be the dominant ion within a few seconds of sunset (contrary to observation), formation of O^+ from O_2^+ notwithstanding.

M.R.C.McDowell

20891 PRELIMINARY DATA ON SOLAR EXTREME ULTRAVIOLET RADIATION IN THE UPPER ATMOSPHERE.

H.E.Hinteregger.

J. geophys. Res. (USA), Vol. 66, No. 8, 2367-80 (Aug., 1961).

Recent measurements of solar extreme ultraviolet photon fluxes in the upper atmosphere are evaluated. Intensities at the top of the atmosphere are estimated, and experimental values of photon absorption rate densities for August 23, 1960 (cos Z ≅ 0.8 over New Mexico) for various important line emissions below 1027 A and the hydrogen Lyman continuum are described. The reference tables include published data to the end of 1960.

20892 ATMOSPHERIC ION COMPOSITION MEASURED ABOVE WALLOPS ISLAND, VIRGINIA.

H.A.Taylor, Jr and H.C.Brinton.

J. geophys. Res. (USA), Vol. 66, No. 8, 2587-8 (Aug., 1961).

Preliminary results are given from Aerobee 4.09 which was fired to 248 km at 10.47 a.m. E.S.T. on 29 April 1960 into an undisturbed ionosphere, and from Aerobee 4.14 fired to 230 km at 11.41 a.m. E.S.T. on 15 November 1960 into a calming ionosphere immediately after a period of moderate disturbance. There is general agreement with results obtained over Fort Churchill (Abstr. 7626 of 1958) and from Sputnik III (Abstr. 3342 of 1960), except that ions of mass 30 are predominant at 100 km, whereas in the Fort Churchill results for this altitude mass 32 is predominant. As the Churchill data were taken during a polar blackout, the difference may be due to extra ionization by hard X-rays.

D.M.Gilbey

20893 ON THE ORIGIN OF V.L.F. NOISE IN THE EARTH'S EXOSPHERE.

T.Ondoh.

J. Geomagn. Geoelect. (Japan), Vol. 12, No. 2, 77-83 (1961).

At present, there are several theories able to explain the frequency characteristic of dawn chorus. In these theories, the natural thermal noise excited in a manner similar to the operation of a travelling-wave tube, the Doppler-shifted proton cyclotron radiation and the Cherenkov radiation are considered as the origin of v.l.f. noise in the earth's exosphere respectively. This paper indicates that the Cherenkov radiation is the most effective with respect to the emission energy in the above mentioned mechanisms in the earth's exosphere and that Cherenkov radio emissions generated by high speed protons (1.4×10^4 km/sec) entering the ionized exosphere along the earth's magnetic field may be excited simultaneously by the operation of the mechanism similar to a travelling-wave tube (due to charged particles different from those causing the Cherenkov radiation). The amplified emissions then propagate toward the earth in the whistler mode.

20894 TERRESTRIAL EXOSPHERE AT HEIGHTS OF 1000-1700 km.

M.Römer.

Nature (GB), Vol. 191, 238-40 (July 15, 1961).

Values of physical parameters are calculated from orbital data for Echo I satellite.

H.Rishbeth

DENSITY IN A PLANETARY EXOSPHERE. See Abstr. 18038

20895 ON THE COMPOSITION OF THE TERRESTRIAL EXOSPHERE.

H.K.Paetzold.

Z. Naturforsch. (Germany), Vol. 16a, No. 5, 521-3 (May, 1961). In German.

In order to fit density profiles deduced from satellite orbits, current exospheric models require the existence of more hydrogen than is consistent with spectroscopic observations, or of a large temperature gradient. Alternatively, the presence of a dust component, of density 4×10^{-19} g cm^{-3} at 1600 km altitude is suggested.

H.Rishbeth

20896 HELIUM, AN IMPORTANT CONSTITUENT IN THE LOWER EXOSPHERE.

M.Nicolet.

J. geophys. Res. (USA), Vol. 66, No. 7, 2263-4 (July, 1961).

It is suggested that the slow decrease of atmospheric density between the heights 750 km and 1500 km is due to the presence of helium. The required amount of helium is consistent with estimates of the rate of loss of helium from the atmosphere.

D.M.Schlapp

20897 VARIATIONS OF THE EARTH'S EXOSPHERE AND GEOMAGNETIC DISTURBANCES DURING THE GEOMAGNETIC STORM OF 4 SEPTEMBER 1958.

T.Ondoh.

J. atmos. terrest. Phys. (GB), Vol. 22, No. 4, 233-54 (Sept., 1961).

20898 EVIDENCE OF THE LAMINAR NATURE OF THE EXOSPHERE OBTAINED BY MEANS OF GUIDED HIGH FREQUENCY WAVE PROPAGATION.

R.M.Gallet and W.F.Utlaut.

Phys. Rev. Letters (USA), Vol. 6, No. 11, 591-4 (June 1, 1961).

Reports a series of experiments involving the propagation of high frequency (13.7 Mc/s) signals in the exosphere. This propagation mode can be used to examine the laminar structure of the exosphere and to investigate the characteristics of the permanent ring current detected by artificial earth satellites.

H.J.A.Chivers

20899 A NOTE ON WHISTLERS OBSERVED ABOVE THE IONOSPHERE.

J.C.Cain, I.R.Shapiro, J.D.Stolarik, J.P.Heppner.

J. geophys. Res. (USA), Vol. 66, No. 9, 2677-80 (Sept., 1961).

The sensing coil of the proton precession magnetometer carried on the Vanguard III satellite also served as an antenna for detecting audio-frequency electromagnetic waves. A preliminary analysis is given for about one hundred whistlers observed between September 18 and December 12, 1959, at low latitudes over the altitude range 510 to 3750 km. About 90% of the whistler occurrences were between 6 p.m. and 6 a.m. local time indicating a low night-time absorption by the ionosphere. The intensity of the H component of the wave is estimated to be between 0.01 and 0.5 γ, with that of a few signals exceeding 1 γ.

20900 THE DISTRIBUTION OF MINOR IONS IN ELECTROSTATIC EQUILIBRIUM IN THE HIGH ATMOSPHERE.

P.Mange.

J. geophys. Res. (USA), Vol. 65, No. 11, 3833-4 (Nov., 1960).

In an atmosphere in diffusive equilibrium, the scale height of the predominant ion is twice that of the corresponding neutral atom, whereas the concentrations of light ions which are minor constituents (such as H^+ and He^+) increase with altitude.

H.Rishbeth

20901 SEASONAL AND DAY-TO-DAY CHANGES OF THE CENTRAL POSITION OF THE S_q OVERHEAD CURRENT SYSTEM.

S.Matsushita.

J. geophys. Res. (USA), Vol. 65, No. 11, 3835-9 (Nov., 1960).

Analysis of IGY geomagnetic data shows that the centre of the S_q current system lies further north in summer than in winter; this contradicts the results of some previous analyses. As the S_q system moves round the earth, its centre tends to follow lines of constant vertical geomagnetic intensity, but with day-to-day variations of several degrees of latitude in its position.

H.Rishbeth

20902 RADIATION FROM A CURRENT FILAMENT ABOVE A HOMOGENEOUS EARTH, WITH APPLICATION TO MICROPULSATIONS.

P.F.Law and B.M.Fannin.

J. geophys. Res. (USA), Vol. 66, No. 4, 1049-59 (April, 1961).

If electromagnetic radiations from ionospheric current systems are considered sources of micropulsations, it becomes instructive to examine the following model problem: What are the electric and magnetic fields in the vicinity of a plane, homogeneous earth due to a line current source above this model earth? As the micropulsation frequencies are quite low (order of 1 c/s), the near-field considerations become significant. The solution for this near field problem is presented and the fields at the earth's surface are evaluated for a set of parameter values chosen to approximate an ionospheric source at a typical micropulsation frequency.

20903 IONIZATION LOSS RATES BELOW 90 km.

C.M.Crain.

J. geophys. Res. (USA), Vol. 66, No. 4, 1117-26 (April, 1961).

Quasi-equilibrium solutions for electron and ion density below 90 km are examined. Special attention is given to the present uncertainty in some of the rate coefficients and to the differences between daytime and night-time results.

20904 YEAR-TO-YEAR CHANGES IN THE WINTER ANOMALY IN IONOSPHERIC ABSORPTION.

L.Thomas.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 215-17 (June, 1961).

20905 IONOSPHERIC CURRENT SYSTEMS OF TEN I.G.Y.-SOLAR FLARE EFFECTS.

D.Van Sabben.

J. atmos. terrest. Phys. (GB), Vol. 22, No. 1, 32-42 (Sept., 1961).

Quantitative analysis of s.f.e. current systems shows that the northern current vortex is generally centred to the west of the southern current vortex and is relatively more intense in northern summer than the southern vortex in southern summer. The total intensity corresponds rather well with the intensity of associated solar flares and ionospheric s.w.f.'s. The current systems of the daily variation at the time of the s.f.e.'s show the same systematic difference in longitude between S- and N-vortex centres. These centres are generally situated at a lower latitude and more to the west than those of the corresponding s.f.e.'s. The features of asymmetry in intensity and position with respect to the equator can be described by an ionospheric current system, the meridional parts of which cross the equator in the morning and noon regions.

20906 THE EFFECT OF SMALL VALUES OF Z = ν/ω ON THE COMPLEX REFRACTIVE INDEX IN THE MAGNETO-IONIC THEORY. H.Unz.

J. atmos. terrest. Phys. (GB), Vol. 22, No. 2, 100-4 (Oct., 1961).

The effect of small values of Z = ν/ω on the general complex refractive index $n = \mu - i\chi$, which includes the magnetic field, is discussed by using McLaurin's expansion. It is shown that the refractive index μ varies only as Z^2 while the absorption coefficient χ varies as Z. For the particular case of no magnetic field the results are identical with the ones derived previously.

20907 USE OF LOGARITHMIC FREQUENCY SPACING IN IONOGRAM ANALYSIS. G.A.M.King.

J. Res. Nat. Bur. Stand. (USA), Vol. 64D, No. 5, 501-4 (Sept.-Oct., 1960).

The use of logarithmic frequency spacing brings several advantages to the reduction of ionograms to electron density profiles. Among them is the fact that, when computing factors for the analysis, one need not determine the group refractive index. Formulae involving only the phase refractive index are presented; for the ordinary component one exact and one approximate formula are given, while for the extraordinary component there is an approximate formula valid over a wide range of geomagnetic latitudes. There is a brief discussion of quasi-longitudinal approximations to the extraordinary phase refractive index.

20908 POSSIBLE IDENTIFICATION OF ATMOSPHERIC WAVES ASSOCIATED WITH IONOSPHERIC STORMS. M.D.Wright.

Nature (GB), Vol. 190, 898-9 (June 3, 1961).

In eight storms starting at night, ionospheric effects commenced earlier at Campbell Island than at Christchurch NZ, 1100 km to the north. It is deduced that the disturbances were propagated at about 500 m $\sec^{-1}$. H.Rishbeth

20909 SCINTILLATIONS AND THE LATITUDE DISTRIBUTION OF IONOSPHERIC IRREGULARITIES. D.G.Singleton.

Nature (GB), Vol. 191, 482-3 (July 29, 1961).

Evidence is presented to show that the variation of scintillations (of transmissions from Sputnik 1) with the observing direction is due to the variation of the incidence of irregularities with latitude. Furthermore, over a region of apparently constant irregularity occurrence it has been found that scintillations are greater when viewing along the magnetic field lines than when viewing perpendicular to them. H.J.A.Chivers

20910 THE NOTATION OF SUDDEN IONOSPHERIC DISTURBANCES (S.I.D.) OBSERVED ON RECORDINGS OF ATMOSPHERICS. F.Carbenay.

C.R. Acad. Sci. (France), Vol. 252, No. 16, 2432-4 (April 17, 1961). In French.

It is proposed that the enhancement of atmospherics during a S.I.D. should be specified by the maximum increase of field strength, instead of the arbitrary index used at present. Some examples are given. H.Rishbeth

20911 THE ELECTRON DISTRIBUTION WITH HEIGHT DURING THE DISTURBANCES IN JULY 1959. B.S.Shapiro and N.I.Potapova.

"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 130-5.

Electron density profiles for the ionosphere over Moscow on disturbed days (11, 15 and 17 July) are reproduced, and compared with those computed from magnetically "quiet day" data. Characteristic "troughs" in the normal F-layer profile were observed to occur almost simultaneously with the sudden-commencement geomagnetic storms. D.R.Barber

20912 IONOSPHERIC BLACK-OUT IN THE POLAR REGIONS DURING JULY 1959 EVENTS. T.Nagata, Y.Hakura and T.Goh.

"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 135-40.

Diagrams are reproduced to illustrate the detailed changes in ionization over the N.polar, and auroral regions that occurred during the period, 10-20 July, 1959. D.R.Barber

20913 THE IONOSPHERIC DISTURBANCE OF NOVEMBER 12 AND 16, 1960. W.S.Campbell and P.L.Hubert.

Canad. J. Phys., Vol. 39, No. 4, 614-16 (April, 1961).

Absorption effects at five ionospheric sounding stations in Canada during the disturbed period were determined from a consideration of the difference between the observed value of the parameter f_{min} and its monthly median value for the same time. G.M.Brown

POLAR IONOSPHERIC DISTURBANCES AND SOLAR CORPUSCULAR RADIATION. See Abstr. 15494

DENSITY FLUCTUATIONS IN A PLASMA IN A MAGNETIC FIELD, WITH APPLICATIONS TO THE IONOSPHERE. See Abstr. 18819

FLUCTUATIONS IN A MULTICOMPONENT PLASMA. See Abstr. 18820

DRIFT RATE IN A DIPOLE FIELD. See Abstr. 18987

20913 EFFECTS OF THE JULY EVENT IN THE LOWER IONOSPHERE AS DEDUCED FROM LONG WAVE PROPAGATION IN MEDIUM LATITUDES. E.A.Lauter.

"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 140-2.

Phase-height measurements at 155 kc/s made at 50° N. lat. on 15 July showed unusually strong absorption in the lower ionosphere during the daytime that lasted up to an hour after sunset. Night-time recovery was fast; and the excess absorption showed a marked decrease with increasing latitude. D.R.Barber

20915 IONOSPHERIC ABSORPTION AND SOLAR ACTIVITY AT MIDDLE LATITUDES. M.Anastassiades, D.Ilias and C.Caroumbalos.

Ann. Geophys. (France), Vol. 17, No. 2, 256-60 (1961). In French.

Systematic measurements of ionospheric absorption made with a Riometer working on frequencies of 27.6 and 58 Mc/s were used to estimate the contribution of the F and D layers, and also that of a layer called "Extra", to the total absorption. Techniques of simultaneous measurements made on two frequencies present some advantage, and may lead to a separation of the D-layer contribution from that of the "Extra" layer. The nature and behaviour of the latter layer is described. By a detailed analysis of the records of the cosmic noise on 27.6 and 58 Mc/s a strong correlation is shown with solar activity. A special study of the solar flares during the week from March 28 to April 30 1960, enabled the radial velocity of sources of bursts in the coronal medium to be determined.

20916 RESULTS OF IONOSPHERIC OBSERVATIONS CARRIED OUT DURING THE TOTAL ECLIPSE OF 15TH FEBRUARY 1961. A.Périneau.

C.R. Acad. Sci. (France), Vol. 253, No. 5, 798-800 (July 31, 1961). In French.

Gives results of vertical and oblique radio soundings taken during the event. A.Boksenber

20917 IONOSPHERIC ABSORPTION ON NOVEMBER 12, 1960. E.L.Vogan and T.R.Hartz.

Canad. J. Phys., Vol. 39, No. 4, 630-5 (April, 1961).

An account of results obtained by the Canadian Radio Physics Laboratory with 30 and 60 Mc/s cosmic noise receivers operated throughout the disturbed period in November, 1960. One interesting observation was the occurrence of a short duration absorption feature coincident with the magnetic storm SC, elsewhere identified as X-ray induced. G.M.Brown

20918 THE PROPERTIES OF LOW FREQUENCY RADIO WAVES REFLECTED FROM THE IONOSPHERE, CALCULATED BY THE PHASE-INTEGRAL METHOD. E.Cooper.

J. atmos. terrest. Phys. (GB), Vol. 22, No. 2, 122-41 (Oct., 1961).

Presents the results of some calculations of the reflecting properties of various models of the ionosphere for radio waves of moderately low frequency at vertical incidence, when allowance is made for electron collisions. The phase-integral method is used, which involves the evaluation of integrals of the complex refractive index n, or the complex group refractive index n' along paths in the complex height plane. The validity of the method and its relation to "full-wave" solutions are discussed. Results presented include a

Chapman layer when the earth's magnetic field is neglected and when it is included. In all calculations, the collision frequency is assumed to be independent of height. It is concluded that the phase-integral method is likely to be the most useful for frequencies in the range 200-2000 kc/s, where a step-by-step integration is very long, and the simpler ray theory methods are not accurate enough.

20919 SOME CHARACTERISTICS OF IONOSPHERIC BACKSCATTER OBSERVED AT 440 Mc/s.

V.C.Pineo, L.G.Kraft and H.W.Briscoe.

J. geophys. Res. (USA), Vol. 65, No. 9, 2629-33 (Sept., 1960).

Incoherent ionospherically backscattered radar returns were observed at 440 Mc/s and approxmiate height range 100-800 km. The results of experiments designed to determine the variation with height of both the intensity and the frequency spectrum of backscattered returns are presented. Backscatter signal-intensity measurements at radio frequencies much greater than the F_2 critical frequency provide an independent means of estimating electron densities. Height profiles of electron densities obtained from experimental data are discussed. Experimentally determined values of the scattering cross-section are approximately equal to the square of the classical electron radius. A typical result of the frequency spectrum measurements at 440 Mc/s indicates a half-power spectrum width of about 11 kc/s at a height of about 300 km during midafternoon of a March day. Spectrum widths observed at several heights and at various times of day and night are discussed.

20920 EFFECT OF THE MAGNETIC FIELD IN IONOSPHERIC BACKSCATTER. E.E.Salpeter.

J. geophys. Res. (USA), Vol. 66, No. 3, 982-4 (March, 1961).

Recent theoretical results for the frequency spectrum of the return signal in radar backscatter from free electrons in the high ionosphere and exosphere have neglected the earth's magnetic field. Some effects due to this field are discussed.

A.Boksenberg

20921 IONOSPHERIC ELECTRON CONTENT AND ITS VARIATIONS DEDUCED FROM SATELLITE OBSERVATIONS.

K.C.Yeh and G.W.Swenson, Jr.

J. geophys. Res. (USA), Vol. 66, No. 4, 1061-7 (April, 1961).

A procedure is given for correcting the effect of refraction and the high-frequency approximation when Faraday rotation measurement is available on two frequencies. This method is used to analyse the records obtained on the ground of radio transmissions from satellite 1958δ_2 (Sputnik III). The result reveals strong diurnal as well as anomalous seasonal variations. The depression in electron content during magnetic storms is identified, and the preliminary observational result is not inconsistent with the drift theory.

20922 DOPPLER SHIFTS AND FARADAY ROTATION OF RADIO SIGNALS IN A TIME-VARYING, INHOMOGENEOUS IONOSPHERE. II. TWO-SIGNAL CASE. J.M.Kelso.

J. geophys. Res. (USA), Vol. 66, No. 4, 1107-15 (April, 1961).

Following procedures applied in Pt I (Abstr. 15261 of 1961) to a single radio signal transmitted to the ground from a space vehicle in or above the ionosphere, equations are obtained for the time rate of change of the phase difference between two signals whose refractive indices are slightly different. These results are applied to the frequency shifts experienced in a two-frequency Doppler experiment of the Seddon—Jackson type, and to the determination of the rate of Faraday rotation of the plane of polarization. The principal restriction on the generality of the results is that the ionosphere is treated as quasi-isotropic; i.e., the ray paths are obtained by methods that would be exact in a slowly varying isotropic medium, but the refractive index is permitted to be a function of ray direction (implying an anisotropic ionosphere). The following conditions prevail: (a) the (slowly varying) ionosphere may be a general function of three spatial coordinates and of time; (b) the vehicle may follow an arbitrary (nonrelativstic) trajectory; (c) the magnetic field, which characterizes the dependence of the refractive index on direction, may have arbitrary form.

20923 THE EFFECT OF FARADAY ROTATION ON INCOHERENT BACKSCATTER OBSERVATIONS.

G.H.Millman, A.J.Moceyunas, A.E.Sanders and R.F.Wyrick.

J. geophys. Res. (USA), Vol. 66, No. 5, 1564-8 (May, 1961).

Observations of incoherent backscatter from a horizontally polarized, high power, 400 Mc/s pulsed radar beam are described. The scattered signal was received on horizontal and vertical polarization. Photographic Range : Time integration records were obtained for 2 elevation angles. The Faraday polarization rotation is calculated using the true electron density profile obtained from ionospheric soundings. The calculations are in close agreement with the experimental data. Maximum polarization was reached at about 700 km height at which point the propagation angle was 90°. It is suggested that the technique would be useful to determine the number of rotations encountered on single frequency lunar transmissions, and also to determine the absolute electron density profiles from the relative values deduced from circularly polarized backscatter soundings.

D.Llanwyn-Jones

20924 OBSERVATIONS OF HYDROMAGNETIC EMISSIONS.

L.R.Tepley.

J. geophys. Res. (USA), Vol. 66, No. 6, 1651-8 (June, 1961).

Deals with preliminary results of a frequency—time analysis of geomagnetic micropulsations in the frequency range 0.5-5 c/s. The data from which these results derive were recorded near Palo Alto, California, November 18-21, 1960. At times, oscillatory signals of slowly varying frequency were observed continuously for periods of many hours. Signals of more rapidly varying frequency were also observed, but for shorter periods of time, usually 10 to 30 min. Oscillations at the same frequencies were found to occur simultaneously on waveform records obtained at California Institute of Technology stations near Ely, Navada, and near Isabella and Mount Palomar, California. The oscillations are called hydromagnetic (hm) emissions, since preliminary evidence implies that they are generated either above or high in the ionosphere and are propagated downward by hydromagnetic waves. The period preceding and including the interval during which data were obtained was characterized by solar-flare activity that produced a number of geophysical effects and undoubtedly influenced the nature of the oscillations.

20925 MEASUREMENT OF IONOSPHERIC DRIFT BY RADIO-STAR OBSERVATIONS. B.Dueño.

J. geophys. Res. (USA), Vol. 66, No. 8, 2355-65 (Aug., 1961).

Measurements of the fluctuations of the signals from the radio-star Cassiopeia were made at Lajas, Puerto Rico. It was found that there exists at this location a great increase in fluctuation activity during June and July which appears to be associated with the large-scale changes taking place in the F_2 layer during the presunrise period. No significant relationship between fluctuation activity and E_s or between fluctuations and spread F was observed. Measurements of drift velocity by means of three spaced interferometers were also made. It was found that drift is toward SE in the evening hours and toward NW in the morning with transitions occurring at noon and at midnight. About 75% of all the drift measurements taken were easily analysable by Putter's method (Abstr. 6644 of 1955). This is taken to mean that for 75% of the cases the random changes in the shape of the irregularities were either very small of were taking place very slowly in time compared with that taken by the irregularity to drift along the three interferometers.

20926 TRANS-EQUATORIAL BACKSCATTER OBSERVATIONS OF MAGNETICALLY CONTROLLED IONIZATION.

J.A.Thomas.

Nature (GB), Vol. 191, 792 (Aug. 19, 1961).

Comparison of the range-azimuth records obtained with a rotating backscatter equipment at Brisbane operating on a frequency of 16 Mc/s with the parallel of magnetic latitude 20°N shows that the echoes generally lie close to this line. Echo ranges vary from 6000 to 12 000 km.

G.M.Brown

20927 HORIZONTAL DRIFTS IN THE IONOSPHERE IN RELATION TO RANDOM FADING.

E.Bhagiratha Rao and B.Ramachandra Rao.

J. sci. industr. Res. (India), Vol. 20B, No. 7, 301-3 (July, 1961).

Fading and drift measurements in the ionosphere, carried out for a period of two years (1956-58) at Waltair at frequencies of 4.6, 5.8, and 7.0 Mc/s, were analysed. It was observed that a linear relationship exists between drift speed and fading frequency. The spread angles for the three frequencies 4.6, 5.8 and 7.0 Mc/s, which were found to be small, show a gradual decrease with increase in frequency. The possible reasons for obtaining spread angles lower than those reported by earlier investigators are given.

20928 ON THE LARGE SCALE REGIONS OF IRREGULARITIES PRODUCING SCINTILLATION OF SIGNALS TRANSMITTED FROM EARTH SATELLITES.

J.Frihagen and J.Tröim.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 215-16 (March, 1961).

20929 RANDOM FLUCTUATIONS IN VERY LOW FREQUENCY SIGNALS REFLECTED OBLIQUELY FROM THE IONOSPHERE. J.K.Hargreaves.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 155-66 (March, 1961).

Describes the analysis of observations made on the amplitude fluctuations of very low frequency signals received from transmitters at Varberg, Sweden, and Annapolis, U.S.A. The observations were made at numerous receiving points simultaneously at ranges between 800 and 6000 km from the transmitters. The fluctuations in amplitude were of the order of 0.15 of the mean amplitude at 1000 km range and of the order of 1.02 at 6000 km range. From the calculated correlation between observations at two separated locations the size and movements of the ionospheric irregularities causing the fluctuations were deduced. The correlation patterns were between 50 and 120 km wide and the fading times of the order of 20 min. The fluctuations were due mainly to changes in their structure rather than to drifts. The measured changes in the phase difference between the signals received at two separated points have been compared with those deduced from the amplitude measurements and good agreement was obtained. The nature of the changes in the ionosphere which give rise to the fluctuations were studied with the aid of data obtained from phase and amplitude measurements at short distances from the 16 kc/s transmitter at Rugby. It is found that the ionosphere modulates the phase rather than the amplitude of the wave and that a model of the ionosphere in which the reflection coefficient is constant and the height fluctuates is in conformity with the observed fluctuations at the ground.

20930 CORRELATION ANALYSIS OF THE FADING OF RADIO WAVES REFLECTED VERTICALLY FROM THE IONOSPHERE. G.F.Fooks and I.L.Jones.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 4, 229-42 (April, 1961).

The correlation analysis of Briggs et al. (1950) and Phillips and Spencer (1955) was applied to the fading of radio waves reflected from the E- and F-regions of the ionosphere, observed at three closely spaced receivers. Histograms are presented showing the size of the characteristic ellipse of the radio diffraction pattern formed on the ground, and also the axial ratio and the direction of the major axis of this ellipse. Results are presented which show the importance of random changes in the pattern relative to pure drift in producing fading. Corresponding results from other parts of the world are reviewed briefly. Drift velocities found by correlation analysis are compared with those found by the simple time-delay method, and it is shown that the errors in the time-delay method are considerable. A comparison is made between the method of calculation used by Briggs et al. and the six-point method of Yerg (1955); the former is to be preferred.

20931 A NEW METHOD FOR THE ANALYSIS OF IONOSPHERIC h'(f) RECORDS. J.E.Titheridge.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 1, 1-12 (April, 1961).

A method is given for calculating the real heights of reflections in the ionosphere, at a number of given frequencies, from the observed virtual heights at those frequencies. The complete real height curve is assumed to consist of a single smooth curve through the calculated points. This gives more accurate results than the lamination methods generally used, in which the real height curve is approximated to by a number of linear segments. So for routine calculations the present method requires less than half as many points as the lamination methods.

20932 A SOLUTION OF THE INTEGRAL EQUATION $h'(f) = \int\mu'(f;\, f_0)\, dz(f_0)$. H.Unz.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 1, 40-5 (April, 1961).

An alternative method for the solution of this equation is given. The solution involves expansion of the functions in a power series. It is believed that this solution is superior in some respects to previous methods. It is assumed that there are no collisions.

20933 GENERAL EXPRESSION FOR THE GROUP REFRACTIVE INDEX OF THE IONOSPHERE.

Y.S.N.Murty and S.R.Khastgir.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 1, 65-9 (April, 1961).

A general expression for the group refractive index of the ionosphere is deduced. Considering the relevant quadrants for the phase-difference between the normal and the abnormal components of the magnetic vector of the radio wave, the general expression gives the values of the group refractive index for the ordinary and the extraordinary modes for different frequencies and for different electron-densities and electron-collisional frequencies of the ionospheric medium and also under different conditions of the earth's magnetic field.

20934 THE FADING OF RADIO WAVES REFLECTED FROM THE IONOSPHERE AT OBLIQUE INCIDENCE. O.Awe.

J. atmos. terrest. Phys (GB), Vol. 21, No. 2-3, 120-41 (June, 1961).

The fading of radio waves reflected from the ionosphere at oblique incidence was studied by the use of pulse transmissions on frequencies near 2 Mc/s. It is found that echoes reflected from a height of about 90 km have a fading period of about 1 min. Echoes from a greater height of about 120 km, which usually appear only during or immediately after magnetic disturbances, have a shorter fading period of about 6 sec. A clear distinction between reflections from these two levels is urged for an understanding of the fading of echoes from the E-region. The spatial characteristics of the diffraction pattern on the ground were studied by the use of three spaced receivers. Possible models for the ionospheric irregularities which would explain the results are considered. It is suggested that the irregularities at heights near 90 km have the form of horizontal discs, that the irregularities near 120 km are spherical, and that the irregularities near 300 km are elongated along the direction of the earth's magnetic field, with an axial ratio of about 3 : 1.

20935 THE RADIO REFRACTIVE INDEX GRADIENT OVER THE BRITISH ISLES. J.A.Lane.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 157-66 (June, 1961).

Reference atmospheres, specifying the average change of refractive index at radio frequencies with height, are derived from basic meteorological data. The atmospheres are represented by the equation $N_h = N_s e^{-bh}$, where N_s and N_h are the average values of $(n - 1) \times 10^6$ at the surface and at a height h respectively, n being the refractive index. This exponential relation is in agreement with the results of a series of measurements with a microwave refractometer. The variations in N_s and b over the British Isles are relatively small in comparison with the changes observed in other areas (e.g. over the United States); however, some local effects are evident which are illustrated in maps of N_o, the average value of $(n - 1) \times 10^6$ at sea level. A high correlation is found between N_s and ΔN (the average decrease in the first kilometre) but ΔN for a given N_s is slightly smaller for the region of the British Isles than for the United States.

20936 THE FADING OF RADIO WAVES WEAKLY SCATTERED AT VERTICAL INCIDENCE FROM HEIGHTS NEAR 90 km. O.Awe.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 142-56 (June, 1961).

The fading of radio waves weakly scattered at vertical incidence from heights near 90 km was studied. Frequencies between 2 and 3 Mc/s were used. The fading rate was found to be of the order of 20 maxima/min, considerably faster than the fading rate for echoes from the normal E-region observed with the same frequency. The correlation between fading records obtained with aerials separated by about one wavelength was found to be small. The shape of the echo was found, on some occasions, to be approximately that expected for reflection from a completely rough screen. These results imply that appreciable energy is returned from directions well away from the vertical. It is shown that the fading is mainly due to random movements of the scattering elements, rather than a steady drift, and the root mean square velocity of the scatterers is found to be about 13 m/sec.

20937 A STATISTICAL STUDY OF IONOSPHERIC DRIFTS MEASURED BY THE RADIO STAR SCINTILLATION TECHNIQUE. H.J.A.Chivers.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 4, 221-4 (July, 1961).

Ionospheric drifts were measured by the radio-star scintillation spaced receiver technique and histograms are presented showing the magnitudes and directions of the drifts observed. The direction of drift is commonly found to reverse suddenly near 2300 hours local time, but the complementary reversal occurs at a less definite time during the following day.

20938 INVESTIGATION OF IONOSPHERIC ABSORPTION ON 5·65 Mc/s AT WALTAIR.

K.V.V.Ramana and B.Ramachandra Rao.

J. atmos. terrest. Phys. (GB), Vol. 22, No. 1, 1-11 (Sept., 1961).

Presents the results of measurements conducted at Waltair (Latitude) 17·7°N, Longitude 83·3°E and Geomagnetic Latitude 7·4°N) during the International Geophysical Year and International Geophysical

-operation periods. The solar zenith distance variation of urnal and seasonal data of absorption follows a law of the form

$$8{\cdot}7\,|\log_e \rho| = A_1 \cdot (f)^{-2}\,.\,\cos^n \chi \text{ dB}$$

lly as an approximation. The variation of the cos χ index has a gnificant negative correlation with Zürich relative sunspot umber R. The monthly mean diurnal variation as well as asonal noon-time variation of absorption confirms, more ecisely, to a law of the form

$$|\log_e \rho| = A' + B\,.\,F(f_0E/f)\cos\chi \text{ nepers}$$

here A' is a constant expected to refer to the non-deviative osorption in lower D-region. A' is found to vary linearly with R. method is suggested to estimate the relative amounts of D- and -region absorption at noon from the cos χ index data. The bsorption $|\log_e \rho|$ and A' are found to vary inversely as the quare of the operating frequency.

20939 THE FADING OF RADIO WAVES REFLECTED VERTICALLY FROM THE IONOSPHERE DURING AGNETIC STORMS. G.F.Fooks.

. atmos. terrest. Phys. (GB), Vol. 22, No. 1, 43-9 (Sept., 1961).

Some features of the reflection of radio waves from the onosphere at vertical incidence during magnetic storms are escribed, and it is shown how correlation analysis can be pplied to the fading at such times. The analysis shows that the rregularities in the diffraction pattern on the ground are smaller and more nearly aligned with the earth's magnetic field than they are for quiet conditions. Drift is a much more important source of ading than random changes in the pattern. The drift velocity s large, and is usually directed toward the West.

20940 IONOSPHERIC INFORMATION DEDUCED FROM THE DOPPLER SHIFTS OF HARMONIC FREQUENCIES FROM EARTH SATELLITES. O.K.Garriott and A.W.Nichol.

J. atmos. terrest. Phys. (GB), Vol. 22, No. 1, 50-63 (Sept., 1961).

A very simple method is derived for the calculation of the ionospheric electron content from the observation of the Doppler shifts on two harmonically related frequencies. A more complicated technique, involving digital computers, may be used to calculate the variations of electron content during the satellite's passage. These methods were applied to five passages of 195862 (Sputnik III) in March 1960. The results indicate the existence of appreciable ionization as low as 90 km, and are consistent with the absence of a valley between the E- and F1-regions near local noon. Irregularities in electron content were found below a height of 175 km, with variations in content of several per cent and horizontal extents of 50-200 km.

20941 IONOSPHERIC REFLECTIONS BELOW 50 KILOMETERS DURING POLAR-CAP ABSORPTION EVENTS. J.B.Gregory.

J. geophys. Res. (USA), Vol. 66, No. 8, 2575-7 (Aug., 1961).

Observations were made at Scott Base, Antarctica at a frequency of 2.3 Mc/s. During periods of strong absorption, partial reflections were observed from heights of less than 50 km, and normal partial reflections from heights of 80-90 km were absent. A preliminary estimate suggests that the electron concentration below 50 km was not less than 100 cm^{-3}. Some evidence from simultaneous observations from satellites suggests that high-energy solar protons were responsible. D.M.Schlapp

20942 SMALL-SCALE POLAR-CAP ABSORPTION AND RELATED GEOMAGNETIC EFFECT. G.F.Rourke.

J. geophys. Res. (USA), Vol. 66, No. 5, 1594-5 (May, 1961).

A class-2 solar flare on 16 December 1957 was accompanied by short-wave fade-out and major radio noise bursts on 500 and 200 Mc/s. Curves of f_{min} for seven Canadian stations show a definite increase at high-latitude stations 16 hours later. A polar-cap absorption event of small intensity persisted until a sudden commencement geomagnetic disturbance occurred on 19 December 1957. Tabulated values of level of magnetic activity show greater disturbance in the polar-cap than in the auroral zone on 17 December. This is stated to be related to the influx of corpuscular radiation. Intensification of the polar-cap current system due to these particles would produce a higher level of geomagnetic disturbance in the polar regions. R.S.Read

20943 PROCEEDINGS OF THE SYMPOSIUM ON POLAR CAP ABSORPTION HELD AT KIRUNA GEOPHYSICAL OBSERVATORY OF THE ROYAL SWEDISH ACADEMY OF SCIENCE, 8-11 August 1960.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 401-538 (1961).

25 papers were presented at the Symposium. Nine of the papers were or are being published elsewhere, abstracts of the remaining 16 follow immediately this abstract.

20944 POLAR IONOSPHERIC BLACKOUTS ASSOCIATED WITH INTENSE SOLAR FLARES.

T.Obayashi and Y.Hakura.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 403-14 (1961).

"Polar cap absorption" symposium paper. Radio blackouts due to enhanced ionizations are classified into two characteristic types; one is the polar-cap blackout and the other is the auroral-zone blackout. It is shown that the polar-cap blackout appears with some hours delay after a major solar radio outburst of type IV, and the blackout is confined within the geomagnetic latitude of about 60°-65°. The estimated energies of particles causing this are of about 10-100 MeV. The auroral-zone blackout then follows, being accompanied by geomagnetic storms and aurorae, and it may be caused by the so-called auroral particles of 1 MeV or less. The energy spectrum of solar particles associated with solar flares is deduced from the present result, together with all information on solar and terrestrial disturbances. It is concluded that solar particles have a conspicuous suprathermal non-Maxwellian tail extending from a few keV up to relativistic energy range, though the bulk of corpuscular clouds consists of rather low energy particles and hence likely to be in the Maxwellian distribution.

20945 THE HEIGHT OF THE POLAR CAP ABSORPTION LAYER. B.Hultqvist and J.Ortner.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 419-26 (1961).

"Polar cap absorption" symposium paper. Height determinations based on disturbance-free records of the diurnal absorption variation occurring during polar cap absorption events are reviewed, and evidence supporting the interpretation of Hultqvist and Ortner (1959) is discussed.

20946 THE GEOMAGNETIC STORM EFFECT ON POLAR CAP ABSORPTION.

J.Ortner, H.Leinbach and M.Sugiura.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 429-34 (1961).

"Polar cap absorption" symposium paper.

20947 X-RAYS ACCOMPANYING THE MAGNETIC STORM OF JUNE 27, 1960. R.R.Brown.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 435-9 (1961).

"Polar cap absorption" symposium paper. A burst of X-rays was observed at balloon altitude with the onset of a sudden commencement geomagnetic storm at 0146 UT on June 27, 1960. The electron bombardment of the upper atmosphere which gave rise to the X-rays occurred on a large scale, ionospheric disturbances associated with the event being observed at College, Alaska and Kiruna, Sweden.

20948 SOLAR PROTONS FROM THE FLARE OF JULY 10, 1959. R.R.Brown and R.G.D'Arcy.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 443-7 (1961).

"Polar cap absorption " symposium paper. From a series of balloon flights launched from College, Alaska in July 1959, observations of the radiation from the solar flare of July 10, 1959 were obtained. The proton component of the radiation, largely responsible for the polar cap absorption at that time, had a steep energy spectrum. In addition, it was accompanied by a strong gamma-ray component, penetrating deep into the atmosphere. Possible origins of the gamma radiation are discussed.

20949 SOLAR COSMIC RAYS AND SOFT RADIATION OBSERVED AT 5 000 000 km FROM EARTH [IN THE SPACE PROBE PIONEER V].

R.L.Arnoldy, R.A.Hoffman and J.R.Winckler.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 451-4 (1961).

"Polar cap absorption" symposium paper.

20950 A POLAR CAP ABSORPTION ROCKET EXPERIMENT. D.C.Rose.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 455-6 (1961).

"Polar cap absorption" symposium paper.

20951

RESULTS OF CONTINUOUS 24-HOUR SOLAR RADIO PATROL, ESPECIALLY IN CONNECTION WITH THE OCCURRENCE OF TYPE IV SOLAR RADIO [EMISSION] EVENTS.

A.D.Fokker.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 459-67 (1961).

"Polar cap absorption" symposium paper.

20952

LABORATORY EXPERIMENTS CONCERNING A POLAR CAP INJECTION MECHANISM.

J.M.Okada.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 473-8 (1961).

"Polar cap absorption" symposium paper. Preliminary observations made with the Stormertron, a laboratory terrella device, suggest that a time-dependent radial electric field superimposed on a magnetic dipole field may furnish a mechanism whereby charged particles can be accelerated and precipitated into the magnetic polar-cap regions, followed by auroral precipitation and subsequent longitudinal drift at subauroral latitudes. A description of the laboratory experiment is given and the problems involved are discussed.

20953

INFLUENCE OF POLAR CAP ABSORPTION EVENTS ON V.L.F. PROPAGATION.

A.Egeland, B.Hultqvist and J.Ortner.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 481-8 (1961).

"Polar cap absorption" symposium paper. Between September 1958 and September 1960 eleven periods of absence of the sunrise and sunset minima of the 16 kc/s signal strength from Rugby were noted at Kiruna in northernmost Sweden. Ten of these instances coincided with the ten polar absorption periods recorded during that time, and even the eleventh case of anomalous v.l.f. propagation may have been associated with similar phenomena. The propagation effect was observed well before the start of the geomagnetic storm and there was close correlation between the intensity and duration of the v.l.f. propagation effects and the corresponding parameters of the polar cap absorption. The conclusion is that polar cap absorption and the anomalous v.l.f. propagation are caused by the same agent, high-energy protons originating from the solar flare. The corollary is that protons arrive even below the geomagnetic latitude of 60 degrees—usually the approximate lower limit of the absorption effect—even prior to the onset of the geomagnetic storm.

20954

SOME RESULTS CONCERNING THE BEHAVIOUR OF LONG DISTANCE V.L.F. CIRCUITS DURING POLAR CAP ABSORPTION EVENTS.

K.W.Eriksen and B.Landmark.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 489-96 (1961).

"Polar cap absorption" symposium paper. During the polar cap absorption events of May and July 1959, marked reductions of the field strength occurred on some long distance v.l.f. circuits recorded in Norway.

20955

A COMMENT ON JUPITER'S RADIO EMISSION AT LONG WAVELENGTH IN RELATION TO SOLAR ACTIVITY.

J.W.Warwick.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 497 (1961).

A short note extending the previous paper (Abstr. 1659 of 1961).

"Polar cap absorption" symposium paper. A short not extending the previous paper (Abstr. 1659 of 1961).

20956

PROPAGATION OF SOLAR COSMIC RAYS THROUGH INTERPLANETARY MAGNETIC FIELD.

T.Obayashi.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 499-505 (1961).

"Polar cap absorption" symposium paper. The time-delay of polar-cap absorptions and of geomagnetic storms, which followed after an intense solar radio outburst of type IV, indicates that solar cosmic-ray particles originating to the west of the solar central meridian reach the earth earlier and more easily than those from the east. A model of the interplanetary magnetic field, which may be appropriate for the explanation of this evidence, is given. The interplanetary magnetic field will be formed by the outward-streaming solar winds which carry the imbedded solar magnetic fields, the lines of force being linked with the sun itself. The rotation of the sun produces a curvature of streams and consequently of the lines of force, which are convex towards the west. Since the injected solar particles will tend to travel along the existing magnetic lines of force, this model can give the explanation of the western excess of solar cosmic rays as well as the inequality of their travel-time with respect to the heliographic position. It is shown that the estimated intensity of the magnetic field is found to be of the order of 10^{-3} to 10^{-5} gauss near the earth's orbit.

20957

ENTRY OF HIGH ENERGY PARTICLES INTO THE POLAR IONOSPHERE.

T.Obayashi.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 507-21 (1961).

"Polar cap absorption" symposium paper. An explanation is given for two types of enhanced ionizations in the polar ionosphere associated with geomagnetic storms: the polar-cap blackout and the auroral-zone blackout. The former appears several hours after major type IV radio outbursts, yet well before the onset of geomagnetic storms, while the latter is closely related to geomagnetic disturbances. It is shown that polar-cap blackouts are caused by the invasion of energetic protons of 10-100 MeV which are precipitating into polar ionosphere following nearly the Störmer orbits. For the auroral-zone blackouts, an improved version of Störmer's theory is applied, in which an interesting behaviour of a charged particle in the distorted geomagnetic field is revealed. The remarkable equatorward shifting of the auroral zone and peculiar world-wide increase of cosmic-ray intensity during the main phase of geomagnetic storms are explained consistently by the decrease of geomagnetic cut-off for incoming particles owing to the distortion of the outer geomagnetic field.

20958

IONOSPHERIC EFFECTS OF SOLAR PROTONS.

R.R.Brown and R.A.Weir.

Ark. Geofys. (Sweden), Vol. 3, Paper 21, 523-9 (1961).

"Polar cap absorption" symposium paper. The attenuation of cosmic radio noise produced by the ionizing effects of solar flare protons was calculated. These calculations, in conjunction with riometer observations during a polar cap event, were used to estimate the flux of protons incident on the atmosphere.

20959

ENERGY DISSIPATION OF SPIRALLING PARTICLES IN THE POLAR ATMOSPHERE.

K.Maeda and S.F.Singer.

Ark. Geofys. (Sweden), Vol. 32, Paper 21, 531-8 (1961).

"Polar cap absorption" symposium paper.

IONOSPHERIC INVESTIGATIONS BY RADAR-LUNAR REFLECTIONS AT LOW GEOMAGNETIC LATITUDE.

See Abstr. 15555

THE EDGE FOCUSING OF A RADIO SIGNAL RECEIVED FROM OUTSIDE THE EARTH BY AN AERIAL WITHIN THE IONOSPHERE.

See Abstr. 18145

20960

THE ANISOTROPY OF TURBULENCE AT THE METEOR LEVEL.

J.P.Dougherty.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 210-13 (June, 1961).

Estimates are made of the approximate size at which ordinary isotropic turbulence with negligible buoyancy effects gives way to anisotropic turbulence at the 90 km level. It is concluded that only a trivial proportion of the total kinetic energy of the irregular motions observed at the meteor level of the ionosphere can reside in the isotropic part of the spectrum. G.M.Brown

20961

FLUCTUATIONS OF ELECTRON DENSITY IN THE IONOSPHERE.

E.A.Novikov.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 3, 587-9 (July 21, 1961). In Russian.

A theoretical discussion of processes which determine the form of ionospheric irregularities. At about 100 km altitude, irregularities are elongated in the direction of the geomagnetic field; it is suggested that at about 65 km they are cruciform, and extend in directions inclined to the field. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 7, 611-12 (Jan., 1961)]. H.Rishbeth

20962

SOME RESULTS OF DIRECT PROBING IN THE IONOSPHERE.

W.Pfister, J.C.Ulwick and R.P.Vancour.

J. geophys. Res. (USA), Vol. 64, No. 4, 1293-7 (April, 1961).

Electron and ion density gradients were determined by means of a sounding rocket carrying two probes, an antenna impedance probe and a retarding potential probe. The electron density was determined as a function of altitude assuming the collision frequency to be known and neglecting the effects of the geomagnetic field. Two frequencies were employed using impedance probes, 3.0 Mc/s and 7.2 Mc/s. Antenna mismatch was recorded at 87 km for 3.0 Mc/s, and at 92 km for 7.2 Mc/s frequency. For an unknown reason measurements were also obtained from 200 to 140 km altitude during descent for the 7.2 Mc/s probe. These latter results require correction by a factor of 6 to agree with the ion probe results. Using the ion probe the positive ion density below 170 km was determined from ascent data and above this height densities were determined for ascent and descent. D.Llanwyn-Jones

0963 EXTENSIONS OF THE "CHAPMAN" THEORY OF LAYER FORMATION. C.H.Cummack.

geophys. Res. (USA), Vol. 66, No. 6, 1685-97 (June, 1961).

An attempt is made to establish sone of the theorems necessary the extension of the "Chapman" theory of layer formation to the se where a spectrum of ionizing radiation acts on an atmosphere th any temperature profile. Some invariant properties of the ectron production function are established, and they are proving eful in estimating the temperature and temperature variations the ionosphere.

20964 THE CONDUCTIVE "CHAPMAN" LAYER. C.H.Cummack.

geophys. Res. (USA), Vol. 66, No. 9, 2751-5 (Sept., 1961).

The shape of the electron production function, when ionizing diation acts as an atmospheric heat source, is given for atmoseres in mixed or diffusive equilibrium.

20965 NOTE ON A MECHANISM FOR THE VERTICAL TRANSPORT OF IONIZATION IN THE IONOSPHERE. I.Axford.

anad. J. Phys., Vol. 39, No. 9, 1393-6 (Sept., 1961).

The mechanism suggested is essentialy a convective process which ionization is caused to be carried down from a reservoir uch as the E-region in a series of layers which may be quite dense nd well defined.

A.Boksenberg

20966 THE LOWER LAYERS OF THE IONOSPHERE (C, D AND E) IN THE LIGHT OF INFORMATION HEORY AND THE PROBLEM OF PROPAGATION OF LONG AND ERY LONG RADIO WAVES AROUND THE EARTH. E.Krasnushkin.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 67-70 (July 1, 1961). n Russian.

Gives results of calculations relating to the reflection of different electromagnetic modes, using assumed models of the onosphere. [English translation in: Soviet Physics—Doklady USA)].

H.Rishbeth

20967 EXCESSIVE IONIZATION IN THE LOWER IONOSPHERE AND INSTABILITIES IN THE OUTER RADIATION BELT. E.A.Lauter.

Naturwissenschaften (Germany), Vol. 48, No. 13, 473-4 (1961). n German.

Some features of the abnormal absorption on frequencies of less than 500 kc/s during magnetic storms are explained in terms of the behaviour of the outer van Allen radiation belt.

D.M.Schlapp

20968 A MODEL OF SOLAR-FLARE-INDUCED IONIZATION IN THE D REGION. R.C.Whitten and I.G.Poppoff.

J. geophys. Res. (USA), Vol. 66, No. 9, 2779-86 (Sept., 1961).

With data from the Naval Research Laboratory Sunflare II rocket observation of a class 2^+ solar flare that occurred on August 31, 1959, and the 18 Mc/s cosmic noise intensity record obtained during the flare, a model of flare-induced ionization in the D region was constructed, and a value for the dissociative recombination coefficient obtained. An experiment to determine the validity of the model and to obtain more precise values of the recombination coefficients is suggested.

D-LAYER IONIZATION AND METEOR ECHOES DURING 12-16 NOVEMBER, 1960 SOLAR EVENT. See Abstr. 18174

20969 THE POSSIBLE IMPORTANCE OF NITRIC OXIDE FORMATION DURING POLAR-CAP IONOSPHERIC ABSORPTION EVENTS. L.Herzberg.

J. geophys. Res. (USA), Vol. 65, No. 10, 3505-8 (Oct., 1960).

It is suggested that solar cosmic rays emitted during flares initiate reactions in the ionospheric D region, leading to the formation of nitric oxide. This NO is ionized by solar ultraviolet radiation and gives rise to the diurnally-varying "polar cap" absorption. Alternative hypotheses involving negative ions are criticized.

H.Rishbeth

20970 IONIZATION IN THE NIGHT IONOSPHERE (CORPUSCULAR HYPOTHESIS). G.S.Ivanov-Kholodnyi and L.A.Antonova.

Dokl. Akad. Nauk SSSR, Vol. 140, No. 5, 1062-5 (Oct. 11, 1961). In Russian.

The soft electrons detected in rocket and satellite experiments may play an important role in the ionosphere. Penetration depths of these electrons and rates of ion production are calculated; it is concluded that a flux of 10^{11} electrons cm^{-2} sec^{-1}, of average energy 100 eV, could maintain the E and F layers at night.

H.Rishbeth

20971 THEORY OF ELECTROSTATIC FIELDS IN THE IONOSPHERE AT POLAR AND MIDDLE GEOMAGNETIC LATITUDES. J.R.Spreiter and B.R.Briggs.

J. geophys. Res. (USA), Vol. 66, No. 6, 1731-44 (June, 1961).

An analysis is presented of the properties of the elongated electrostatic fields that provide the coupling mechanism required in the dynamo-motor concept of the E and F regions of the ionosphere. This concept has been proposed in recent years to account for a variety of observed phenomena ranging from large-scale effects associated with tidal flows in the F region to small-scale effects associated with the scintillation of radio signals from radio stars or from space vehicles. The analysis is developed for an electrostatic field of arbitrary horizontal scale in a horizontally stratified partially ionized gas subject to an imposed magnetic field selected to be representative of conditions in polar and middle geomagnetic latitudes. The anisotropic character and continuous variation with height of the conductivity are retained throughout, and numerical solutions are determined for the attenuation of the electric field with height above the dynamo region. The results show that the attenuation is much less than that which would be experienced in a homogeneous medium, and that it is possible, for instance, for electrostatic fields having horizontal scale as small as about 3 or 4 km to extend from 130 km to 400 km with a loss in magnitude of only about 25%. The results also show that relatively small changes in the ionospheric conditions, well within the range of possibilities, can result in very substantial changes in the attenuation of the electric field with height.

20972 THEORY OF ELECTROSTATIC FIELDS IN THE IONOSPHERE AT EQUATORIAL LATITUDES. J.R.Spreiter and B.R.Briggs.

J. geophys. Res. (USA), Vol. 66, No. 8, 2345-54 (Aug., 1961).

The properties of the elongated electrostatic fields that are required to provide the coupling mechanism in the dynamo-motor concept of the E and F regions of the ionosphere are examined theoretically for the conditions that prevail in equatorial latitudes. The analysis is developed for an electrostatic field of arbitrary horizontal scale in a horizontally stratified partly ionized gas subject to an imposed magnetic field having the form of a parabolic arch over the equator. The anisotropic character and continuous variation with height of the conductivity are retained throughout, and numerical solutions are determined for the attenuation of the electric field with distance along the field line. The results are similar qualitatively to those found previously upon analysis of the corresponding problem for middle latitudes, but the attenuation of the electrostatic field with height is considerably greater. It develops, in particular, that the coupling between E and F regions is very small for fields having horizontal wavelengths of a few kilometres. It follows that the dynamo-motor concept could not be used to account for the presence of irregularities of this scale. On the other hand, it is found that almost all the attenuation occurs at heights near that of the E region. If an electrostatic field having a horizontal wavelength of a few kilometres could be produced at heights of, say 200 km or greater, it follows that it would be very elongated and extend with little change in amplitude from hemisphere to hemisphere. The results also indicate that effective coupling could be achieved for fields having horizontal wavelengths of the order of tens of kilometres, but the assumptions introduced to simplify the analysis may impair the quantitative reliability of the results for fields of this scale.

20973 STUDIES OF THE E-LAYER OF THE IONOSPHERE. II. ELECTROMAGNETIC PERTURBATIONS AND OTHER ANOMALIES. E.Appleton and A.J.Lyon.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 73-99 (June, 1961).

Pt I of this paper (Abstr. 766 of 1960) was devoted to the derivation of various quantitative relations by which the experimentally observed behaviour of the E-layer could be explained in terms of current theories of ionized layer formation and variation. It was there shown that two valuable criteria in this connection are (a) the nature of the diurnal asymmetry of $N_m(E)$ when corresponding forenoon and afternoon values are compared and (b) the dependence of the mean level of $N_m(E)$, the layer maximum electron density, on cos χ, where χ is the solar zenith distance. Departures from the predictions of simple theory were identified by comparing

E-layer characteristics observable at different times at a given station, and at the same time at different stations. For example, studies of diurnal asymmetry in f_0E and h'E indicate departures from theoretical predictions; and, moreover, disclose opposite trends in high and low latitudes which are identified as geomagnetic perturbations arising from the motor effect of the S_q system of currents flowing in the E-layer. The same geomagnetic distortion is identified as one main reason why f_0E is not a unique function of $\cos\chi$ under comparable conditions. For example, at a solstice noon, the maximum value of f_0E does not occur at the sub-solar point, but on the equatorial side of it. This and other phenomena suggest that, quite generally, the motor effect of the S_q current is to raise f_0E in low latitudes, and reduce it in high latitudes, with reference to its basic value produced by solar radiation. Simple theory suggests that, in the E-layer, N_m should be, substantially, proportional to $(\cos\chi)^{1/2}$ at all times when N_m is not changing too rapidly, as is the case over the greater part of the hours of daylight. Experimental evidence, however, shows that for the diurnal variation at constant latitude, and also for a latitude variation at constant time (such as noon), N_m varies approximately at $(\cos\chi)^{2/3}$. This and other anomalies, such as the considerable variation of f_0E at constant χ, and the anomalous asymmetry observed at low $\cos\chi$, are also discussed.

20974 A LONG TERM VARIATION IN THE RELATIONSHIP OF SUNSPOT NUMBERS TO E-REGION CHARACTER FIGURES. R.Naismith, H.C.Bevan and P.A.Smith.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 167-73 (June, 1961).

During the last 25 years there has been a progressive increase in sunspot numbers at the maximum of each cycle. Over the same period ionospheric measurements indicate that the E-region ionization corresponding to a given sunspot number has decreased. This change has necessitated an adjustment of the empirical constants in the expression relating sunspot numbers to E-region character figures which is used in forecasting E-region critical frequencies.

20975 A STUDY OF THE VARIATIONS IN A DAILY IONOSPHERIC INDEX OF SOLAR ACTIVITY.
G.H.Bazzard.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 193-202 (June, 1961).

Values of a daily index of solar activity, based on the ionization of the E-layer, are presented for the period of IGC 1959 as a continuation of values already published for the IGY. Variations in the index during the whole period of $2\frac{1}{2}$ years were examined statistically and evidence obtained of periodicities resulting from localized active areas on the sun and its rotation. The variations in the ionospheric index were also shown to be partially correlated with coronal green line activity which suggests that solar conditions conclusive to the excitation of the green line are also favourable to the emission of E-layer ionizing radiation.

20976 STUDY OF HORIZONTAL DRIFTS IN THE E-REGION AT WALTAIR. R.Raghava Rao and B.Ramachandra Rao.
J. atmos. terrest. Phys. (GB), Vol. 22, No. 2, 81-99 (Oct., 1961).

Results of analysis of drift data for the E-region taken at Waltair over a period of 2 years are presented. The main features of diurnal and seasonal variation of drifts in the E-region at this low latitude station are compared with earlier results from high latitude stations. The 24 hourly drift vector is predominant in all seasons. This shows clockwise rotation in all seasons except summer. The 12 hourly drift vector is invariably smaller than the 24 hourly drift vector and shows clockwise rotation in all seasons. The steady component is generally directed towards SSE. The polar plots of 24 hourly and 12 hourly drift vectors show highly elliptical forms, the major axes being oriented nearly along E—W and N—S respectively. The results are compared with the winds deduced from E-region levels from S_q-variations.

20977 THEORY OF OVERHEAD NONBLANKETING SPORADIC E. J.Renau.
J. geophys. Res. (USA), Vol. 66, No. 7, 2121-8 (July, 1961).

A model is suggested for overhead nonblanketing sporadic E based upon scattering from a belt (1 or 2 km in thickness) of irregularities within a stratified E layer. Predicted h'f curves are compared with observed data and found to be in good agreement.

20978 SOME OBSERVATIONS OF THE OCCURRENCE AND MOVEMENT OF SPORADIC-E IONIZATION.
J.Harwood.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 4, 243-62 (April, 1961).

A rotating-aerial back-scatter sounder was used at 17 Mc/s to examine the location, approximate size, and movements of clouds o sporadic-E ionization for the period May—August 1959, as part of a European co-operative experiment involving a number of vertical-incidence sounding stations. Clouds, of average diameter about 200 km and average duration 2 hr, were seen more frequently to the south than to the north. One third of them drifted, predominantl towards the south-west, at a mean speed of 60 m/sec. There was good correlation between the occurrence of back-scatter echoes propagated by way of E_s clouds, one-way propagation over a 700 km path by the same means, and the occurrence of high E_s critical frequencies at a few vertical incidence sounders. To account for a lack of correlation between other drift measurements and E_s cloud movements, it is suggested that the former are based on the fine structure of the cloud, whereas the latter depend on observatio of the main cloud boundaries.

20979 SPORADIC-E PHENOMENA ASSOCIATED WITH THE HIGH ALTITUDE NUCLEAR EXPLOSIONS OVER JOHNSTON ISLAND. L.Thomas and R.E.Taylor.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 205-8 (June, 1961).

20980 IRREGULARITIES IN THE E_s LAYER OF THE IONOSPHERE. G.F.Fooks.
Nature (GB), Vol. 190, 707-8 (May 20, 1961).

Analysis of Cambridge observations of the motion of E_s layer irregularities does not reveal any preferred direction of drift. The size of the irregularities is very variable, and in contrast to results at other latitudes, they are not markedly elongated.

H.Rishbeth

20981 THE RELATIONSHIP OF LOW-HEIGHT IONOSONDE ECHOES TO AURORAL-ZONE ABSORPTION AND V.H.F. D SCATTER. J.K.Olesen and J.W.Wright.
J. geophys. Res. (USA), Vol. 66, No. 4, 1127-34 (April, 1961).

Weak diffuse h.f. reflections at heights between 75 and 95 km in the auroral zone are designated E_sd. Diurnally, E_sd occurs most frequently at noon at all seasons, and shows a pronounced minimum of occurrence around 2000 hr local time. There is little evidence for a seasonal variation from the year's data presented here. It is suggested that E_sd is related to the anomalies of auroral-zone absorption and that it is the layer responsible for v.h.f. forward scatte

20982 EFFECT OF ELECTRON—ION COLLISIONS IN THE F REGION OF THE IONOSPHERE ON THE ABSORPTION OF COSMIC RADIO NOISE AT 25 Mc/s AT AHMEDABAD. CHANGES IN ABSORPTION ASSOCIATED WITH MAGNETIC STORMS. K.R.Ramanathan, R.V.Bhonsle and S.S.Degaonkar.
J. geophys. Res. (USA), Vol. 66, No. 9, 2763-71 (Sept., 1961).

Measurements of comic radio noise at 25 Mc/s, made at the Physical Research Laboratory, Ahmedabad, since March 1957, show much larger values of absorption than those observed by Shain and Mitra in Australia (Abstr. 4045 of 1954). This fact, together with the empirically known dependence of the absorption on the critical frequency of the F region, and the effect of magnetic storms on the absorption found from the Ahmedabad observations led the authors to examine the different possible parameters that may affect cosmic-noise absorption. It was found that electron—ion collisions in the F region both below and above the level of maximum electron density contribute in a substantial way to the absorption of cosmic radio noise. The values of hourly absorption due to collisions of electrons with neutral particles and with ions were calculated for a period of 6 days in August-September 1957, when there were three magnetic storms. The results obtained show a depletion of electrons above F maximum on the day following the commencement of the magnetic storm and a refilling on later days. The results are discussed in relation to findings from satellite observations about particle fluxes in the Van Allen belts during magnetic storms.

20983 DECAY OF IONIZATION BELOW THE F-LAYER AT NIGHT. P.Bandyopadhyay and S.K.Chatterjee.
Indian J. Phys., Vol. 35, No. 5, 240-4 (May, 1961).

The experimental results of Titheridge (Abstr. 14217 of 1960) variation of the total amount of ionization below the night-time F-layer are re-examined. It is shown that it is not possible, on the basis of the above results, to discriminate between Titheridge's constant α-model and Mitra's (Abstr. 763-4 of 1960) time dependent α-model. On other physical grounds, however, it is concluded that while Titheridge's model will possibly hold in the upper part of the region studied, Mitra's model will be valid near the bottom.

0984 A LOCAL REDUCTION OF F-REGION IONIZATION DUE TO MISSILE TRANSIT.

H.G.Booker.

eophys. Res. (USA), Vol. 66, No. 4, 1073-9 (April, 1961).

This paper describes and interprets an unusual echo received ocal ionospheric sounders for a period of about ½ hr subsequent ne firing of Vanguard II.

20985 COMMENT ON PAPER BY HENRY G.BOOKER, "A LOCAL REDUCTION OF F-REGION IONIZATION E TO MISSILE TRANSIT".

C.Barnes, Jr.

eophys. Res. (USA), Vol. 66, No. 8, 2589 (Aug., 1961).

Booker suggested that a "hole" in the ionosphere could form ause the hot rocket exhaust gases would rise and be replaced by atively un-ionized air from below. The author now suggests that exhaust gases themselves, cooled by expansion, would have an ctron density less than one-tenth that of the ionosphere, and ld constitute a "hole". D.M.Gilbey

20986 THE COUPLING BETWEEN THE PROTONOSPHERE AND THE NORMAL F REGION.

B.Hanson and I.B.Ortenburger.

geophys. Res. (USA), Vol. 66, No. 5, 1425-36 (May, 1961).

The proton distribution in the upper portion of the F_2 region ust follow a chemical equilibrium distribution up to a critical vel, h_c, which is determined by the condition $\lambda\Lambda = H^2$, where λ is e mean free path for the scattering of protons by oxygen ions, is the charge-exchange mean free path for protons among oxygen oms, and H is the scale height of atomic oxygen. Above this itical level, the distribution of protons is governed by diffusion. e number of protons in the whistler medium (that is, the protonohere) is large enough, and the rate of diffusion of protons through ygen ions slow enough, so that no large diurnal changes in istler-region ion concentrations can be expected. This is in reement with observation. The weak coupling between the oxygen ns in the normal F_2 region and the protons in the protonsphere nds support to the position that the protonosphere should be onsidered separately from the heavy-ion region which constitutes e normal ionosphere; the protonosphere can be thought of, in rge degree, as floating on top of the normal ionosphere.

20987 PHOTOIONIZATION HEATING IN THE F REGION OF THE ATMOSPHERE.

D.C.Hunt and T.E.Van Zandt.

geophys. Res. (USA), Vol 66, No. 6, 1673-82 (June, 1961).

The thermal economy in the F region of the atmosphere is investigated using the barometric equation and the continuity equation for thermal energy. It is concluded that photoionization is certainly a major source, and possibly the predominant source, of F-region heating. The assumptions and approximations are discussed and are shown not to invalidate the conclusion. The heat flux due to photoionization in the F region at low and middle latitudes at sunspot maximum is estimated to lie between 0.5 and 2.0 ergs $cm^{-2} sec^{-1}$, with a most probable value of about 1.0 ergs $cm^{-2} sec^{-1}$.

20988 ON THE INFLUENCE OF HORIZONTAL MOTION OF THE NEUTRAL AIR ON THE DIFFUSION EQUATION OF THE F-REGION.

J.P.Dougherty.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 167-76 (March, 1961).

The motion of the ionization in the F-region is calculated, taking into account diffusion, electrostatic fields, the magnetic field, and in addition, an arbitrary horizontal "wind" in the neutral air. Horizontal variations of all quantities are neglected. The vertical component of velocity is used to obtain a "diffusion equation" in the usual way. The reaction of the ions on the neutral air (through collisions) is then studied. An equilibrium can be set up in a time of the order of half an hour, and if this does happen, the vertical velocity induced by the electrostatic field is drastically reduced compared with its value when the neutral air is at rest; the horizontal drift velocity, however, is increased. Further, the factor $\sin^2 I$ modifying the diffusion coefficient is removed. Thus the diffusion equation is altered considerably. An attempt to discuss the worldwide consequences of this effect shows the need for further study of possible causes of motion of the neutral air.

20989 ION—NEUTRAL REACTIONS.

M.Hertzberg.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 177-82 (March, 1961).

Since the rate coefficients for exoenergetic ion—neutral metatheses are of the order of 10^{-9} cm^3 sec^{-1}, they dominate in controlling the positive ion composition of the ionosphere. Under a reasonable set of assumptions, an equation is derived relating the degree of nitrogen dissociation to the ionic composition. From this relationship, it is concluded that the nitrogen of the F-region is substantially dissociated.

20990 THE F-LAYER AT SUNRISE.

H.Rishbeth and C.S.G.K.Setty.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 4, 263-76 (April, 1961).

The behaviour at sunrise of the ionospheric F-layer was investigated, using records made at Slough and Cambridge during the years 1953-1958. The rate of increase of electron density at fixed heights, just after F-layer sunrise, is greater at sunspot maximum than at sunspot minimum, and greater in winter (December) than in summer (June); the latter effect appears to be associated with the well-known seasonal anomaly in F2-layer electron density. It is suggested that the rate of increase of electron density depends principally on the rate of production of ionization. The seasonal changes might be caused by a change of composition of the upper atmosphere. In the F-region electrons are produced by the photoionization of atomic oxygen; the radiation absorbed by molecular nitrogen does not contribute appreciably to the observed ionization, because molecular ions are short-lived in the F-region. Consequently a change in the ratio of the concentrations of these gases can alter the effective production rate; it can also affect the loss rate, which depends on the concentration of molecular gases. In the discussion, vertical transport of ionization is neglected but horizontal movement has to be considered. The calculations of production and loss rates are of limited accuracy, but yield plausible orders of magnitude.

20991 DIFFUSION ON IONIZATION IN THE SUNRISE F-LAYER.

H.Rishbeth.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 4, 277-88 (April, 1961).

The variation at sunrise of F-layer electron density has been computed for some simple isothermal models of the ionosphere, taking into account the processes of production, loss and plasma diffusion. In some examples, the effects of vertical drifts caused by electromagnetic forces are included, the drift velocities being assumed independent of height but not necessarily independent of time. It is found that, near the peak of the F-layer, the rate of increase of electron density depends primarily upon the production rate, and is not greatly influenced by diffusion or vertical drift. The level at which the peak is found is lowered by the action of diffusion, however, and also depends upon the electromagnetic drift.

20992 ROCKET MEASUREMENTS OF F-LAYER ELECTRON DENSITY AND THEIR INTERPRETATION.

S.A.Bowhill.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 4, 272-83 (July, 1961).

Solutions of the continuity equation for ionospheric electron density including the effects of ambipolar diffusion, near the peak of the F-layer, indicate that the width of the peak is determined by the atmospheric scale height at night, but is less during photoequilibrium conditions during the day. This conclusion is borne out by rocket electron-density measurements. Evidence is found supporting measurements of diurnal atmospheric heating deduced from satellite drag data, and a thermopause temperature is found of about 1100°K at night and 1490°K during the day. Assuming the classical form for the ambipolar diffusion coefficient, a value of the loss coefficient β is found of about 5×10^{-4} sec^{-1}, at 300 km height, which falls within the range measured by other methods.

20993 THE VARYING ELECTRON DENSITY PROFILE OF THE F-REGION DURING MAGNETICALLY QUIET NIGHTS.

W.Becker.

J. atmos. terrest. Phys. (GB), Vol. 22, No. 4, 275-89 (Sept., 1961).

Ionograms taken at Lindau and at two field stations (average distance from Lindau 125 km) on magnetically quiet nights were reduced to N(h)-profiles of the F-layer. The normalized profiles showed maximum height changes of about 60 km lasting for about 2 hr; they also showed layer height differences on comparable nights of more than 100 km. No seasonal influence on the rise and descent of these profiles in the late evening and early morning hours respectively could be found. The ionograms of the field stations did not show any local difference or temporal displacement. Generally, the electron loss rate at the F-layer peak is closely related with the height of the peak and therefore dependent on season. Spread-F echoes of high intensity are occasionally observed at Lindau even on magnetically quiet nights; they are not necessarily associated with vertical movements of the F-layer. No spread-F echoes were observed during vertical movements of the F-layer induced by positive magnetic bay disturbances. The observations do not decide the question whether vertical movements cause instability-conditions within the F-layer or not.

20994 HEIGHT OF NIGHT-TIME F LAYER IRREGULARITIES AT THE EQUATOR. G.S.Kent and J.R.Koster.
Nature (GB), Vol. 191, 1083-4 (Sept. 9, 1961).

Observations were made at two separated stations of the diffraction pattern produced on the ground when radio transmissions from the satellite Tiros II passed through the irregularities. Knowing the height and velocity of the satellite, the heights of the irregularities could then be determined, and were found to lie always between 50 and 100 km above the base of the F layer.
D.M.Schlapp

20995 CHANGES IN THE ELECTRON DENSITY DISTRIBUTION IN THE IONOSPHERE OVER AHMEDABAD ASSOCIATED WITH SOLAR FLARES AND MAGNETIC STORMS. I. July 10-19, 1959. S.S.Degaonkar.
Proc. Indian Acad. Sci. A, Vol. 54, No. 1, 24-35 (July, 1961).

Describes changes in the F region electron density profiles during a disturbed period. Hourly values of peak electron density and total electron content below the peak are given. H.Rishbeth

20996 AN ANALOGUE SOLUTION OF THE CONTINUITY EQUATION OF THE IONOSPHERIC F REGION.
B.H.Briggs and H.Rishbeth.
Proc. Phys. Soc. (GB), Vol. 78, Pt 3, 409-22 (Sept., 1961).

It is shown that the continuity equation for the electron density in the F-region of the ionosphere can be solved by the use of an electrical analogue. The equation which is solved in this way takes account of the rates of production and loss of electrons, and of vertical diffusion, but other types of movement are not included. The rates of production, loss and diffusion are assumed to vary with height in a manner appropriate to a particular model of the atmosphere, based on rocket and satellite data. The analogue computer is first used to find how the electron density at a series of heights varies with time due to the diurnally varying rate of production. The time of maximum production is at noon, but the time of maximum electron density occurs some time after noon, and the variation of this time lag with height is studied. Near noon, the electron density is found to be a maximum at a height of 250 km. In the evening, the height of the maximum rises to about 300 km, and remains constant during the night. Above the level of the maximum, the ionization is controlled by diffusion and the ionization density falls off exponentially with increasing height; its time variation follows closely the time variation at the maximum. In other experiments, the production function is modified so as to represent a solar eclipse which occurs near noon. Diurnal curves of electron density are obtained at a series of heights, and the results show how the time of maximum electron density and the percentage decrease of electron density vary with height. In another type of experiment, the diffusion and recombination of a slab of ionization introduced at a fixed height are studied. It is shown that the slab spreads out to form a "layer" which eventually assumes a certain fixed shape with a maximum at a fixed height of 300 km, and that this "shape-preserving" layer then decays with a time constant determined by the rate of recombination at the level of maximum ionization density. The final form of the layer is independent of the height at which the slab of ionization is introduced. These results may be relevant to the behaviour of the F-layer at night when production is absent, and diffusion and recombination are the controlling factors.

20997 SOLAR FLARE EFFECTS IN THE F REGION OF THE IONOSPHERE. R.W.Knecht and K.Davies.
Nature (GB), Vol. 190, 797-8 (May 27, 1961).

On two occasions during 1960, a marked increase of F2 layer electron density followed large solar flares, which were accompanied by the emission of BeV particles. The increases were observed at single stations only; an effect on oblique incidence propagation of 20 Mc/s signals is also reported. The data are compared with two previous instances of F-region flare effects.
H.Rishbeth

20998 THEORETICAL WORLD CURVES OF MAXIMUM F2 IONIZATION. II. J.E.C.Gliddon and P.C.Kendall.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3. 183-8 (March, 1961).

For previous Pt, see Abstr. 14243 of 1960. Values of N_mF2 were computed from an analytical solution of the equation governing diffusion of ions in the F2 region. The mathematical model takes account of electron production, attachment-like recombination and a rate of diffusion which depends upon the ambient air density and also on the geomagnetic latitude. Results are plotted on a grid of geomagnetic latitude and local time and are compared with curves drawn from world-wide ionosonde records.

20999 AN ION-TRAP MEASUREMENT OF THE ION CONCENTRATION PROFILE ABOVE THE F_2 PEAK.
W.B.Hanson and D.D.McKibbin.
J. geophys. Res. (USA), Vol. 66, No. 6, 1667-71 (June, 1961).

An ion trap with plane-parallel geometry was flown on a Javelin rocket to an altitude of 1000 km above Wallops Island, Virginia, at 8.44 p.m. local time on November 9, 1960. The ion concentration was measured from 240 to above 700 km; above 350 km the concentration profile can be well represented by a hydrostatic distribution of ions of mass 16 with a constant temperature of approximately 1240°K.

21000 ON VERTICAL DRIFT VELOCITIES OF THE F2-LAYER. H.Unz.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 4, 237-42 (July, 1961).

The vertical drift velocities of the F2-layer are calculated approximately from the N(z,t) measured curves. A correlation between the calculated velocities and the velocity of the position of the 0.9N(max) is shown and discussed.

21001 EFFECTS OF CORPUSCULAR EMISSIONS ON THE POLAR IONOSPHERE FOLLOWING SOLAR FLARES.
G.E.Hill.
J. geophys. Res. (USA), Vol. 66, No. 8, 2329-35 (Aug., 1961).

The morphology of two polar absorption events, July 24-25 and September 18-22, 1957, representing different types of ionospheric disturbances, is presented. It was found that in both events the absorption was more intense in the sunlit portion of the polar cap than in the darkened portion by several megacycles, and that following the polar cap absorption event (PCA) of the September storm, strong auroral zone absorption occurred, a geomagnetic storm developed, and the F_2 layer critical frequency decreased markedly, whereas following the July PCA none of these additional disturbances appeared.

21002 ANALYSIS OF THE F_1-F_2 TRANSITION REGION. G.A.M.King.
J. geophys. Res. (USA), Vol. 66, No. 9, 2757-62 (Sept., 1961).

Describes a method of deducing rates of electron production and loss and the atmospheric scale heights at the height of the transition between the F_1 and F_2 layers of the ionosphere. The electron density profile obtained from the ionogram is transformed into dimensionless coordinates and compared with a set of theoretical curves parametric in a factor, G, which determines the shape of the transition region. The assumptions under which the theoretical curves are derived are clearly set out. The method is accurate enough to permit the study of changes in the ionosphere during a day.

21003 MAGNETIC EFFECTS IN THE F-REGION OF THE IONOSPHERE. J.W.King.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 1, 26-34 (April, 1961).

Plots of f_0F2 versus the equivalent planetary daily amplitude, Ap, show that at night f_0F2 decreases as the magnetic disturbance increases. During the midnight period an A_p of 35 is found to reduce the ionization below the value corresponding to zero magnetic disturbance by $\sim 65\%$ in all seasons and for all the stations investigated. The "half-life" of the ionization as deduced from critical frequency values during the night is shown to be dependent on the value of Ap, and decreases from 5.0 hr for nights of small magnetic disturbance to about 3.0 hr for disturbed nights. The amount of magnetic disturbance thus controls both the amount of ionization present before midnight and the fraction of this transferre to the next day. It is shown that this mechanism could be responsible for the day-to-day correlation of f_0F2 values. A method for selecting ionospherically quiet and disturbed days is suggested, and it is shown that the magnetically selected 5Q days are not generally ionospherically quiet; the days immediately after the 5Q days are much more likely to be ionospherically quiet. It is shown that during the mid-day period the median critical frequency is the frequency corresponding to no magnetic disturbance, while days which are disturbed may have frequencies which are greater or smaller than the median, the amount greater or smaller depending on the value

p. The greatest variability of the ionosphere is shown to occur ight rather than during the day; this, together with the fact that s of f_0F2 before midnight unexpectedly form a set of divergent ves, is due to magnetic effects.

21004 DAY-TO-DAY AND STATION-TO-STATION CORRELATION OF IONOSPHERIC F-REGION CRITICAL EQUENCIES. J.W.King.

tmos. terrest. Phys. (GB), Vol. 21, No. 1, 35-9 (April, 1961).

The cross-correlation of f_0F2 observed at different stations is nd to have a diurnal variation with two maxima and two minima h day. The phase of this variation appears to exhibit a seasonal nge with reversals of direction at the equinoxes. The mean ss-correlation coefficient is 0.5 for stations on the same north—th line and separated by 2000 km, and also for stations having same latitude and a separation of only 1000 km. The diurnal iation of cross-correlation is shown to be unrelated to solar al effects. The auto-correlation of critical frequencies from a gle station indicates that there is an important relationship ween the value of f_0F2 at a particular hour and the value at the me hour on the day before. The diurnal variation of the auto-rrelation coefficient has maxima at 0700 and 1900 hours and nima at 1300 and 0100 hours, and exhibits no seasonal change. is correlation is probably due to magnetic effects which determine amount of ionization carried over from one day to the next.

21005 IONOSPHERE CRITICAL FREQUENCIES AND MAGNETIC PARAMETERS OF THE PREVIOUS DAY.

W.Bergh and J.W.King.

atmos. terrest.Phys. (GB), Vol. 22, No. 1, 74-5 (Sept., 1961).

Correlation plots between f_0F2 at 0300 and 0500 hours, and the m of the K-indices for different 24 hr periods shows that the eatest correlation (0.3 in June 1957 and −0.8 in November 1957) tains with magnetic activity in the 24 hr period which ends at 00 hours on the previous day. Plots of 6 hr periods centred at fferent times suggest that the highest correlation is obtained etween magnetic activity in the pre-sunrise period of the preceding y and f_0F2 on the day in question. D.Llanwyn-Jones

21006 ON THE NATURE OF EQUATORIAL SPREAD F.

R.Cohen and K.L.Bowles.

geophys. Res. (USA), Vol. 66, No. 4, 1081-106 (April, 1961).

Ionospheric propagation via scattering from the F region was ought at 50 Mc/s over a transequatorial path (with midpoint near uancayo, Peru) employing a 2580 km transmitter—receiver separa-on. Propagation via F scatter was present over this path about 0% of the time, though only at night. A condition closely related to e occurrence of F scatter was the presence of equatorial spread-F onfigurations on the Huancayo ionograms. The height of the propa-ation medium supporting this F scatter was usually identifiable with the lowest height of the associated equatorial spread F on the onograms. On the basis of an interpretation of experimental results, quatorial spread F is shown to arise from scattering by relatively hin sheets of irregularities in electron density which occur at the ottom of the F layer or as much as 100 km lower. The thickness f these patches is estimated at the order of 50 km. The scattering rregularities comprising these patches are found to be elongated long the earth's magnetic lines of force. Electron irregularities of scale 100 m or smaller measured in at least one dimension trans-erse to the magnetic field lines, and 1000 m or longer measured long the magnetic field lines, are shown to exist as high as 450 km n the nocturnal equatorial F region during equatorial spread-F onditions. Equatorial spread-F echoes observed at Huancayo are demonstrated to be arriving at all elevation angles in the magnetic east—west plane. The geographical extension of a given scattering sheet in the magnetic east—west direction was at times as great as 1000 km. An observational procedure is suggested for distinguishing two fundamental varieties of spread-F echoes appearing on the equa-torial ionograms. A necessary condition, that the contours of mean electron density be parallel to the magnetic lines of force, is pro-posed as a controlling factor for the occurrence of spread-F in the equatorial ionosphere.

21007 DISCUSSION OF A PAPER BY D.S.BUGNOLO, "SPREAD F AND MULTIPLE SCATTERING IN THE IONOSPHERE". J.Renau.

J. geophys. Res. (USA), Vol. 66, No. 5, 1589 (May, 1961).

The author questions whether Bugnolo's theory (Abstr. 15293 of 1961) can explain some aspects of observed spread-F (see also following abstract). D.M.Schlapp

21008 AUTHOR'S REPLY TO THE PRECEDING DISCUSSION.

D.S.Bugnolo.

J. geophys. Res. (USA), Vol. 66, No. 5, 1590 (May, 1961).

The author replies that his theory can be extended to explain the "specular reflections" observed in spread-F traces. Also if the effects of anisotropic turbulence and the earth's magnetic field are included, the theoretical variation with latitude of maximum spread in frequency agrees with Renau's experimental data (Abstr. 15295 of 1961) (see also previous abstract). D.M.Schlapp

21009 EQUATORIAL SPREAD F IN RELATION TO POST-SUNSET HEIGHT CHANGES AND MAGNETIC ACTIVITY.

M.S.V.Gopal Rao and B.Ramachandra Rao.

J. geophys. Res. (USA), Vol. 66, No. 7, 2113-20 (July, 1961).

Equatorial spread F, magnetic activity, and post-sunset rise in h'F are studied in detail as three parameters, and correlations in the variations in each of the three pairs are examined for all the seasons. Partial correlations are sought to examine the independent influence of magnetic activity and h'F changes on spread F. It is observed that the time of maximum spread F on each night is effectively controlled by the magnitude of the h'F change between 1800 and 1900 LT. The results are discussed in the light of the recent theory of spread F outlined by Martyn (Abstr. 11650 of 1959).

21010 EQUATORIAL SPREAD-F AT IBADAN, NIGERIA.

A.J.Lyon, N.J.Skinner and R.W.Wright.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 100-19 (June, 1961).

The characteristics of equatorial spread-F at Ibadan (magnetic latitude 3°S) were investigated including nocturnal, seasonal, solar-cycle and magnetic disturbance variations; and all of these were found to show marked correlations with corresponding changes in the height of the layer. For example spreading begins shortly after the evening rise in the layer, and becomes less intense and more restricted to the higher frequencies as the layer descends later in the night. Also at Ibadan spread-F incidence on quiet days is found to increase with solar activity; this corresponds to a marked increase in the evening rise of the layer as the solar cycle advances. A possible interpretation of these and earlier results that the irregularities responsible for spread-F are due to hydromagnetic disturbances which are increasingly attenuated at lower heights.

21011 NOCTURNAL AND SEASONAL VARIATIONS OF EQUATORIAL SPREAD-F.

M.S.V.Gopal Rao and B.Ramachandra Rao.

J. atmos. terrest. Phys. (GB), Vol. 22, No. 1, 12-22 (Sept., 1961).

A new classification of spread-F echo patterns based on the relative amplitudes of the echoes is described and discussed. The results of nocturnal and seasonal variations in spread-F at Waltair are presented and a comparison is made with data of other equatorial stations with particular reference to that of Kodaikanal. Differences in the seasonal behaviour of spread-F within a geomagnetic latitude range of 0 to ± 7° are considered in relation to the equatorial electrojet.

21012 HIGH FREQUENCY FADING OF THE 108 Mc/s WAVE RADIATED FROM AN ARTIFICIAL EARTH SATELLITE AS OBSERVED AT AN EQUATORIAL STATION. G.S.Kent.

J. atmos. terrest. Phys. (GB), Vol. 22, No. 4, 255-69 (Sept., 1961).

A study was made of the high frequency fading observed on the 108 Mc/s wave radiated from satellite 1959η. This fading had a frequency of a few cycles per second and is believed to be caused by the passage of the waves through irregularities in the F-region of the ionosphere. These irregularities are found to occur only at night and to have a dependence upon magnetic activity and latitude similar to that found for spread-F irregularities. In addition they are found to have a tendency to be concentrated into regions with dimensions of the order of 100 km. The size and shape of the irregularities were deduced from observations on the fading and from spaced aerial measurements. They are elongated along the magnetic lines of force with axial ratios of not less than 5 : 1 and have dimensions perpendicular to the lines of force of about half a kilometre.

21013 THE OCCURRENCE OF THE SPREAD-F AND THE GEOMAGNETIC FIELD. T.Shimazaki.

J. Radio Res. Lab. (Japan), Vol. 7, No. 33, 437-50 (Sept., 1960).

The effect of a geomagnetic storm on the occurrence of the spread-F is first studied. The storms that occurred during January 1957 to September 1959 are classified into several groups according to their intensity and the time (in U.T.) or the season of Sc, and then the occurrence probabilities of the spread-F are compared with each other of various days before and after Sc for each group of the classification. The result shows that the probability increases appreciably on days after Sc at higher latitudes, while it decreases at lower latitudes. This is most apparent in the groups of highest intensity or of equinoctial seasons, although the tendency is appreciable even in the group of lowest intensity. It is also shown that the correlation between the occurrence probability of the spread-F and the magnitude of the geomagnetic field is strongly positive at lower latitudes. This might be understood from the consideration that the turbulence is produced as the result of the breakdown of stability of the laminar flow (ionospheric winds) by the applied magnetic field.

21014 MICROMETEORITE MEASUREMENTS — SATELLITE AND GROUND-LEVEL DATA COMPARED.

W.D.Crozier.

J. geophys. Res. (USA), Vol. 66, No. 9, 2793-5 (Sept., 1961).

Comparison is made between an annual mass accretion to the earth (3.9×10^5 metric tons) calculated on the basis of micrometeorite counts by satellites 1958α and 1959η, and an annual mass accretion of magnetic spherules (0.9×10^5 metric tons) determined by collections made at ground level by the Airborne Particle Study of the New Mexico Institute of Mining and Technology. Both measurements apply to the particle mass interval 3.3×10^{-10} g to 1.2×10^{-8}g. On the basis of the theory of Öpik (Irish Astronomical Journal, Vol. 4, 84-135 (1956), the ratio of the two amounts is quite reasonable, but the entire interpretation becomes uncertain because of the possibility that many of the particles encountered by the satellites may be in orbit around the earth.

21015 EFFECT OF MAJOR METEORIC SHOWERS ON THE DENSITIES OF THE UPPER ATMOSPHERE.

S.I.Rasool.

Science (USA), Vol. 134, 385-6 (Aug. 11, 1961).

Using data obtained by Lagow and Alexander, Dublin, and Nazarova (1960) from satellite measurements, it is calculated that the energy injected into the upper atmosphere during a major meteor shower will be sufficient to raise the temperature in the 110-120 km region by ~ 5°K in 6 hr, equivalent to an energy dissipation of ~ 600 erg cm^{-2} hr^{-1}. The effect will be to increase the upper atmospheric density by 5 to 8%, in agreement with that obtained by satellite drag measurements at 300 and 600 km.

D.R.Barber

21016 THE DAYGLOW OF THE SODIUM D LINES.

J.E.Blamont and T.M.Donahue.

J. geophys. Res. (USA), Vol. 66, No. 5, 1407-24 (May, 1961).

Observation of the Na dayglow in the scattered sunlight observed on the surface of the earth with a magnetic scanning photometer is reported. The intensity (September to November 1960) is unexpectedly strong — 30 kilorayleighs toward the zenith — and evidence is that during the period studied the amount of Na is 4 times as large in the daytime as at twilight. However, a strong correlation is found between the dayglow and twilight intensities. The abundance can be as high as 40×10^9 atoms cm^{-2}. The possible role of water vapour absorption in the results is discussed.

21017 VARIATIONS OF [O I] 5577 A EMISSION IN THE UPPER ATMOSPHERE.

F.E.Roach.

Ann. Geophys. (France), Vol. 17, No. 2, 172-80 (1961).

A review is given of current knowledge of intensity variations of [O I] 5577 in the upper atmosphere. Evidence is presented for the dependence of the 5577 intensity on various temporal and spatial parameters. The statistical distribution of intensities, the effect of changes in the earth's magnetic field and the co-variance of 5577 and other radiations are discussed. Possible excitation mechanisms include (a) the three-body collision of three oxygen atoms and (b) excitation by electrons "heated" by acceleration in a discharge.

21018 LYMAN-α RADIATION.

H.Friedman.

Ann. Geophys. (France), Vol. 17, No. 2, 245-8 (1961).

The Lyman-α radiation of hydrogen (1215.7 A) plays an important role in many geophysical processes. It is the most prominent line in the solar ultraviolet spectrum and is absorbed in the D-region of the ionosphere where it is capable of ionizing nitric oxide. In the night sky, Lyman-α radiation appears as an intense glow, suffusing the entire hemisphere. The source of the glow is attributable to resonant scattering of solar radiation by an extended hydrogen geocorona.

21019 THE 5577 A AIRGLOW EMISSION MECHANISM.

C.A.Barth and A.F.Hildebrandt.

J. geophys. Res. (USA), Vol. 66, No. 3, 985-6 (March, 1961).

Rocket measurements of the vertical distribution of the 5577 A airglow emission supported a three-body atomic oxygen excitation mechanism proposed by Chapman. Using electron paramagnetic resonance spectrometry and optical spectroscopy, measurements of the rate coefficient for the 5577 A emission were made on a syst of reacting oxygen atoms. Known values of upper atmosphere oxyg densities are used to show that Chapman's mechanism would yield a maximum intensity of 0.2 rayleigh; a typical airglow intensity is 250 rayleighs.

D.J.Barbe

21020 THERMAL RADIATION SPECTRUM OF THE ARCTIC SKY.

W.B.Murcray.

J. geophys. Res. (USA), Vol. 66, No. 3, 987-8 (March, 1961).

The spectrum of atmospheric thermal emission was measured at −30° F in conditions where effects due to nearby water, vegetatio or industry were absent. The measurements cover the wavelength range from 4 to 14 μ. It is concluded, from the emission due to ozone at 9.6 μ, that the effective radiation temperature of the ozonosphere is about −40° to −45° F. An emission at about 14 μ is attributed mainly to carbon dioxide, and it is deduced that the lower atmosphere is not opaque at such wavelengths.

D.J.Barbe

21021 SEASONAL VARIATION AND INTERPRETATION OF THE OH ROTATIONAL TEMPERATURE OF THE AIRGLOW.

L.Wallace.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 85-93 (March, 1961

The cascading to lower vibrational levels, following the formation of the excited OH molecules, is accompanied by a shift of the rotational populations to higher rotational levels if there is no collisional redistribution. This effect would cause the rotational temperature for v = 5 to be significantly higher than for v = 9 for what appear to be reasonable assumptions regarding the primary excitation mechanism. Since the observations indicate that the rotational temperature is the same for all v, it appears that collisional redistribution must occur. A series of thirty-seven spectra of the OH airglow emissions were obtained in the interval December 1958-January 1960. The seasonal variation in the rotational temperatures derived from them is probably less than 30°K and is in phase with the larger variations observed at higher latitu The form of the seasonal variation is similar to the form of the seasonal variation of the sodium abundance but not to that of the auroral frequency.

21022 ON THE OH AIRGLOW.

V.I.Krassovsky, N.N.Shefov and V.I.Yarin.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 1, 46-53 (April, 1961).

An increase of the OH emission intensity with increasing rotational temperature, and seasonal variations of the intensity and rotational temperature of OH have been established by spectral observations at Yakutsk. No such behaviour was observed at Zvenigorod. At both locations variations of the relative populations of the OH vibrational levels and a correlation between the OH and Hα airglow intensities were observed.

21023 THE EXCITATION OF AN AIRGLOW BY RADIO WAVES.

P.Caldirola.

Nuovo Cimento Suppl. (Italy), Vol. 19, No. 2, 235-55 (1961).

In Italian.

Reports a theoretical investigation into the possibility of producing an airglow artificially in a feebly ionized gas under a steady magnetic field by a rapidly alternating electric field. The phenomenon which results resembles the "airglow" produced by Cutolo by directing radio waves from a transmitter on to a vessel about a kilometre away containing dry air at low pressure, and the investigation suggests that it should be possible to produce a visible airglow artificially in the ionosphere.

J.M.Stag

OXYGEN MOLECULE EMISSION IN AIRGLOW AND AURORA.

See Abstr. 17312

21024 VERTICAL DISTRIBUTION OF SODIUM IN THE UPPE ATMOSPHERE.

W.R.Bullock and D.M.Hunten.

Canad. J. Phys., Vol. 39, No. 7, 976-82 (July, 1961).

The sodium twilight was observed over the period October 195 ecember 1959 with a birefringent photometer. Abundances and ical distributions were found for 120 twilights. The abundance ation is similar to that found previously but is more nearly ametrical about the solstices. A small seasonal variation in peak ght is found, 3 to 5 km with maximum in March. In general, nges in abundance cannot be correlated with changes in distri- on; however, a few exceptions to this were found in June and 7, when a large overnight increase in abundance accompanied a ge decrease in the height of the whole distribution.

21025 A NOTE ON THE OBSERVATIONS OF TWILIGHT LITHIUM EMISSION MADE FROM HALLETT ATION. M.Gadsden and K.Salmon.
atmos. terrest. Phys. (GB), Vol. 22, No. 1, 75-8 (Sept., 1961).

The enhancement of twilight lithium emission which was erved in Antartica during August and September 1958, has been cribed either to residual debris from a thermonuclear device or a possible seasonal enhancement. Records for 1959 are alysed and show no lithium emission. A discussion of the 1958 servations is given and the general conclusion is drawn that though the thermonuclear debris hypothesis is possibly the more ely explanation, it is by no means proven. M.Kasha

21026 SOME RESULTS OF THE NIGHT AND TWILIGHT AIRGLOW OBSERVATIONS RECEIVED IN ABASTUMANI JULY 1959. L.M.Fishkova and T.G.Megrelishvili.
uly 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 1961) p. 114-15.

Summarizes in tabular form results of airglow observations ade on 1-2, 2-3, 12-13, and 13-14 July. Intensities of 5 emission atures are expressed in Rayleigh units. D.R.Barber

21027 EMISSION OF THE RED LINE OF THE NIGHT SKY AND THE PROPERTIES OF THE F-LAYER OF THE NOSPHERE. D.Barbier.
R. Acad. Sci. (France), Vol. 252, No. 21, 3315-16 (May 24, 1961). French.

Concurrent night-airglow, and ionospheric observations made Tamanrasset (French Sahara) during the IGY are discussed in elation to the semi-empirical relationship

$$Q = Kf_0^2 \exp[-(h' - 200/H)] + C$$

onnecting the intensity, Q, of airglow emission at 6300 A (unit rightness = 1 rayleigh), and f_0, the critical frequency (in Mc/s) of e F-layer at a virtual base-height of h' km. The constants, K, , and C have the following mean values: K = 2.36; H = 45.3; = 90. The Tamanrasset data yield a good fit to the above relation-hip, and the observed altitudes of the 6300 A arcs lie very close to -layer virtual heights. D.R.Barber

21028 FLUCTUATIONS OF INTENSITY OF THE LINES H_α AND [N II] 6583 A IN THE SPECTRUM OF THE IGHT SKY. J.Dufay, M.Dufay and Nguyen Huu-Doan.
R. Acad. Sci. (France), Vol. 253, No. 7, 974-7 (Aug. 16, 1961). n French.

Results obtained with a fast grating spectrograph (dispersion, 8 A/mm) at the Haute Provence Observatory reveal the existence f marked enhancement of the intensity of both emission lines when he spectrograph points in the direction of galactic H II regions. The much weaker H_α emission observed away from the Galaxy robably originates in the earth's upper atmosphere as a true irglow feature. It is not certain whether the N II line is a permanent eature of the night airglow outside the galactic H II regions. A imilar enhancement of the H_α emission has been reported reviously by Prokudina (Zvenigorod), and Haynoullina and Kariahina (Alma-Ata), 1957-8. D.R.Barber

21029 BEHAVIOR OF THE 6300 OI LINE AT HUANCAYO. S.M.Silverman and M.Casaverde.
J. geophys. Res. (USA), Vol. 66, No. 1, 323-6 (Jan., 1961).

The results presented in this paper confirm the findings of Delsemme and Delsemme (Abstr. 4807 of 1960) and Barbier (Abstr. 18516 of 1960) as to the unexpected behaviour of the forbidden red line of atomic oxygen in the night sky at latitudes near the equator. The results at Huancayo, Peru, show that the intensity of the 6300 OI line passes through a maximum at some time between 2200 and 0200 hours local time. Comparisons with observations at Tamanrasset and at Liviro indicate a strong seasonal effect on the intensities and also a strong latitude dependence of the phenomenon. It is noted that the diurnal variation for the red line is similar to that observed for the H component of the magnetic field in equatorial regions, though for this the maximum occurs at local noon. M.Kasha

21030 STUDY OF VARIATIONS OF THE FORBIDDEN OXYGEN LINES IN THE NIGHTGLOW. M.C.Pande and S.S.Varma.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 2, 195-9 (March, 1961).

The variations of the forbidden oxygen lines in the nightglow are investigated photoelectrically using a fixed orientation photometer set in a star free region near the north celestial pole. For the red lines our observations show that the slope of the evening twilight enhancement portion of the diurnal curve indicates a possible change with season; for the 5577 A emission, the occurrence of a maximum around midnight is confirmed. Little correlation of these emissions with solar activity could be established.

21031 ATTEMPT TO MEASURE NIGHT HELIUM GLOW — EVIDENCE FOR METASTABLE MOLECULES IN THE NIGHT IONOSPHERE. E.T.Byram, T.A.Chubb and H.Friedman.
J. geophys. Res. (USA), Vol. 66, No. 7, 2095-2100 (July, 1961).

An Aerobee rocket flown from White Sands Missile Range at 1115 UT, November 29, 1960, included a first experimental attempt to measure the intensity of the helium glow in the night sky. The experiment provided evidence that the brightness of this glow is less than one tenth the brightness of the night Lyman α glow. The photoelectric detector produced signals that may be interpreted as evidence that a supply of metastable molecules exists in the night ionosphere at altitudes above 100 km.

21032 EXCITATION OF GREEN AND RED LINES IN THE NIGHT AIRGLOW. S.N.Ghosh and A.Sharma.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 110-21 (March, 1961).

The rate of collisional deactivation of excited O atoms which leads to the emission of the λ5577 line in the night airglow has been estimated between the altitudes 50 and 200 km, after taking into account all processes by which these excited atoms may be quenched. The excitation mechanisms of this line are then considered in the light of recent rocket observations which give 100 km as the altitude of its emission. It is found that Chapman's mechanism can alone explain the observed characteristics of the λ5577 line. The diurnal variation of the intensity of this line has been attributed to the tidal oscillations in the upper atmosphere. On the other hand, irregular temporal and spatial variations of this line are caused by turbulence. The excitation of the λ6300 line is also considered. It is found that dissociative recombination of O_2 + ions with electrons leads to the production of the red oxygen line in the night airglow.

21033 THE BEHAVIOUR OF NIGHT-SKY 6300, 5577 AND 3914 A EMISSIONS AT SCOTT BASE, ANTARCTICA. B.P.Sandford.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 182-92 (June, 1961).

The diurnal and seasonal variations and the correlations with magnetic activity of the 6300, 5577 and 3914 A emissions from the zenith at Scott Base are discussed. There is a marked twilight enhancement of 3914 A emission. Most of the emissions at these wavelengths do not originate from visible auroral forms but from extensive glows that can only be observed visually or with all-sky cameras during major magnetic storms.

21034 STATISTICS OF SPATIAL BRIGHTNESS VARIATIONS OF THE [O I] 5577 A LINE IN NIGHTGLOW. U.Haug.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 4, 225-36 (July, 1961). In German.

Photoelectrical records of the [O I] 5577 A line in the nightglow from the Hochalpine Forschungsstation, Jungfraujoch (Switzerland) were analysed under the assumption that the emitting layer lies near 100 km. The brightness variations are mostly below 25% of the mean intensity and exceed 50 % in only 5% of all cases. The variations could be classified either as "local enhancements" or as "gradients of brightness". A simple model calculation shows that the mean diameter of the bright patches is generally not much larger than 1000 km whereas Roach et al. (Abstr. 2026 of 1960) consider airglow cells with diameters of approximately 2500 km.

21035 A PHOTOELECTRIC ANALYZER OF ALL-SKY CAMERA AURORAL PHOTOGRAPHS. T.Nagata and E.Kaneda.
J. geophys. Res. (USA), Vol. 66, No. 7, 2259-61 (July, 1961).

Details are given of a recording apparatus designed for the quantitative analysis of the time-sequence auroral records obtained with an all-sky camera. An approximate luminosity calibration is obtained from zenith-sky twilight records obtained either before, or after the run of auroral frames. Care must be taken to correct for any added moonlight. D.R.Barber

21036 AURORA AND AIRGLOW FROM COLOUR FILM OBSERVATIONS. B.P.Sandford.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 177-81 (June, 1961).

Colour photography with an all-sky camera is a powerful tool for systematic studies of the night-sky emissions. Extensive auroral glows that are not observable visually or on black-and-white film can easily be detected. Type A aurora, usually considered a rare form, may indeed be quite common. The colour of aurora shows some interesting relationships with height effects and magnetic activity.

21037 THE EAST–WEST DRIFT OF AURORAL FORMS DETERMINED FROM ALL-SKY CAMERA FILMS. W.Stoffregen.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 4, 257-60 (July, 1961).

Using all-sky camera observations from a chain of stations lying in a N–S direction from Spitzbergen along the Scandinavian peninsula and crossing the auroral zone, the E–W motions of the auroral forms were studied. It is shown that at stations lying to the south of the auroral zone there is a mean drift towards W before midnight and a mean drift towards E after midnight. At stations lying to the north of the auroral zone the diurnal variation in the drift direction is reversed. A station ~5° south of the auroral zone (Lycksele) shows E–W motions more often than stations in or north of the auroral zone. The close resemblance between the mean diurnal drift directions of auroral forms deduced from all-sky films and the drifts of ionized areas determined from studies of auroral echoes is stressed.

21038 THICKNESS OF AN ACTIVE AURORAL CURTAIN. S.I.Akasofu.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 4, 287-8 (July, 1961).

From a series of photographic studies of the aurora made at College, Alaska, the thickness of an active coronal arc was measured. Upper limits of 336 m and 144 m are given for two exposures taken with a time difference of 5 sec. G.M.Brown

21039 TEMPERATURES DEDUCED FROM AURORA AND AIRGLOW SPECTRA. D.M.Hunten.
Ann. Geophys. (France), Vol. 17, No. 2, 249-55 (1961).

A temperature profile for the upper atmosphere between 70 and 250 km, extended tentatively to 500 km, is constructed from spectroscopic temperatures. The most important are rotational temperatures from N_2^+ negative bands in aurora, both normal and sunlit, and measurements of Doppler widths of the forbidden lines in the night and twilight airglow. The profile has a minimum of 180°K at 90 km and a linear gradient of 5.2 deg/km above 110 km to perhaps as far as 400 km.

21040 NOTES ON AURORAL DATA FOR JULY 1959 IN W.D.C. EDINBURGH. J.Paton.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 113-14.

Describes the main (visual) characteristics of the displays observed in July 1959 at a network of European stations. Data were analysed at the World Data Centre, Edinburgh. D.R.Barber

21041 A PRELIMINARY ACCOUNT OF THE AURORAL DISPLAY OF 15 JULY 1959 AS RECORDED IN AUSTRALIA AND AT A.N.A.R.E. STATIONS. F.R.Bond.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 115-26.

The auroral and geomagnetic activity in the S. hemisphere that accompanied the solar event of 14 July is described in detail, and magnetograms are reproduced to illustrate some features of the geomagnetic disturbance. D.R.Barber

21042 RESULTS OF SPECTROGRAPHIC AND RADAR OBSERVATIONS OF AURORAL AND NIGHT AIRGLOW IN JULY 1959 BY THE STATIONS OF THE ATMOSPHERIC PHYSICS INSTITUTE OF THE USSR ACADEMY OF SCIENCES. A.V.Mironov.
"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 128-30.

Simultaneous spectrographic and visual observations of selected auroral and airglow emission lines are described for individual nights. The various lines recorded are tabulated, together with their estimated relative intensities. D.R.Barbe

21043 A NOTE ON THE ANALYSIS OF SEVEN YEARS' VISUA OBSERVATIONS OF THE AURORA FROM NEW ZEALAND AND CAMPBELL ISLAND. M.Gadsden and M.N.Gadsde
Ann. Geophys. (France), Vol. 16, No. 3, 414-18 (1960).

An analysis of visual auroral records made between 1952 and 1958 with the object of determining: (1) whether the phase of the 11-yr sunspot cycle has an influence on the frequency of their occurrence; (2) whether the summer (Dec.-Feb.) maximum shown in photographic records is confirmed. Results suggest that: (1) the all-sky camera is a better detector of aurorae than a volunteer visu observer; (2) there is no evident influence of the 11-yr cycle other than through the dependence of the geomagnetic K-index on the sunspot cycle; (3) no indication of the Summer maximum appears in the visual records, making it probable that the feature is due to an increase of the number of faint displays that can only be recorded photographically. D.R Barber

21044 THEORY OF AURORAL BOMBARDMENT. J.W.Chamberlain.
Astrophys. J. (USA), Vol. 134, No. 2, 401-24 (Sept., 1961).

An auroral theory is developed from the point of view of particle orbits in an inhomogeneous plasma confined by a magnetic field. Specifically, a mechanism is proposed for ejection into the atmosphere of geomagnetically trapped protons and electrons. It is assumed that the energetic particles are distributed in longitudinal irregularity. The tendency for positive and negative particles to drift in opposite directions will then lead to momentary electrostatic fields, arising from excess charges of one sign aligned along a magnetic line of force. As particles drift into this potential, they lose tranverse kinetic energy, and a portion of the particles immediately spirals out of the ends of the flux tube into the atmosphere. As the potential grows, the drift of particles into this "discharge tube" is inhibited, but more of those entering the potential with high velocity are ejected, regaining their lost transverse kinetic energy in accelerated motion along the magnetic field. The potential may rise sufficiently to discharge particles with energies of several keV within an interval of less than a second, which is rapid enough to render unimportant the neutralization by ionospheric ions and electrons. If the density fluctuations of auroral plasmas exceed a certain critical value, the electrostatic field will cause them to grow rapidly. This instability is identified with auroral-ray structure. A density fluctuation may maintain its identity, even though individual particles are constantly moving through it. This characteristic may be associated with the fading and reappearance of rayed structures. The basic mechanism of electrostatic fields arising from the particle drifts will also produce local accelerations of particles, by tending to establish an equipartition of energy between protons and electrons. This is presumably the mechanism for the local acceleration of auroral electrons, although it will also modify, but less severely, the energy spectrum of trapped protons. Various other consequences of these macroscopic, but short-lived, electric fields are examined, with a view toward understanding auroral morphology. It is proposed that an E × B drift accounts for the statistical preference for auroral patterns to move toward the sunlit hemisphere and for the departures of auroral forms from alignment along circles of geomagnetic latitude, even in the polar cap. The E field, when transferred to the atmosphere by bombardment and by ordinary conduction, will produce a Hall current parallel to auroral motions; this current is identified with the auroral electrojet and associated magnetic disturbances. It is suggested that these considerations also have a bearing on the north-south thickness of auroral forms, on auroral breakup, and on daily variations.

21045 ON THE STATISTICAL PROPERTIES OF OPTICAL AND RADIO AURORA. F.Hector and P.A.Forsyth.
Canad. J. Phys., Vol. 39, No. 10, 1423-8 (Oct., 1961).

The latitudinal variation of certain auroral forms was investigated by means of all-sky camera records made in central Canada during the I.G.Y. The forms chosen were those that may have significance in theories of auroral morphology. The occurrence of "curl forms" seems to be concentrated near the auroral zone. One type of radio reflection (A_2) appears to be associated with the curl forms and another type (A_3) with patchy, early morning aurora, which occurs most frequently well south of the auroral zone.

21046 THE MORPHOLOGY OF THE POLAR AURORA.
T.N.Davis.

geophys. Res. (USA), Vol. 65, No. 10, 3497-500 (Oct., 1960).

A description is given of temporal changes in the spatial auroral ttern observed from stations in the Northern auroral zone. At llege, Alaska, a reversal of the predominantly westerly drift curred at ~ 0130 local time. The main features of this pattern, tained from all-sky camera records during the IGY, suggest a ntring of the pattern on the geomagnetic pole, and its fixation th respect to the sun. D.R.Barber

21047 THEORY OF AURORAL MORPHOLOGY.
J.W.Kern and E.H.Vestine.

geophys. Res. (USA), Vol. 66, No. 3, 713-23 (March, 1961).

A new theory of auroral morphology based on the production instabilities in electron sheets is developed. It is found that the eory predicts a longer duration of homogeneous auroral arcs in e early evening and a shorter duration during morning hours. oserved transitions from glow to homogeneous arcs to ray arcs d draperies are also predicted. An especially interesting feature the lowering of mirror points accompanying development of ighter features of a display. The theory also achieves encourag g success in explaining horizontal and vertical luminous wave ogressions found in flaming aurora.

21048 THE RELATIONSHIP BETWEEN UNIQUE GEOMAGNETIC AND AURORAL EVENTS. Y.Sobouti.

geophys. Res. (USA), Vol. 66, No. 3, 725-37 (March, 1961).

From magnetic data obtained at 11 Canadian stations, the iono pheric current patterns in the auroral zone, during several agnetic storms were sketched and the predominant current atterns determined for each phase of an "average" storm. It is und that the auroral displays tend to occur along current lines. high correlation is found between the geomagnetic latitudes of e southern extents of auroral displays and the most southerly rrent lines. When these two sets of data are plotted against a storm-phase", a southward shift of the aurora is seen to ccompany the southward motion of ionospheric currents.

21049 REPLY TO SOME COMMENTS BY MALVILLE CONCERNING THE MIDNIGHT AURORAL MAXIMUM.
.H.Vestine and J.W.Kern.

. geophys. Res. (USA), Vol. 66, No. 3, 989-91 (March, 1961).

Exception is taken to Malville's statement [Ibid., Vol. 65, No. 9, 008 (Sept., 1960)] that a drop in the height of the mirror point for eomagnetically-trapped radiation of ~ 150 km will be unimportant n promoting auroral activity. The authors point out that, whereas his may be true for altitudes ~ 1000 km, a similar drop at ~ 200 km cannot be ignored. In fact a drop as small as 10 km may well be significant when associated with atmospheric heating by mpinging solar particles, and subsequent expansion.

D.R.Barber

21050 THE HEIGHT AND GEOGRAPHICAL POSITION OF THE RED AURORAL ARC OF APRIL 1-2, 1960.
.G.Moore and F.K.Odencrantz.

. geophys. Res. (USA), Vol. 66, No. 7, 2101-4 (July, 1961).

Simultaneous observations of an auroral arc from Cactus Peak, California, and Fritz Peak, Colorado, on the night of April 1-2, 1960, provided the information necessary to determine the height of naximum luminosity and the geographical position of the arc. Twenty pairs of measurements determined the average height to be 125 km with a standard deviation of ±22 km from the average for a single pair of observations. The arc, observed from a point over the Pacific Ocean off the Oregon Coast to a point over the state of Mississippi, lay generally along a line of equal magnetic inclination.

21051 SOME AURORAL OBSERVATIONS INSIDE THE SOUTHERN AURORAL ZONE. J.V.Denholm.

J. geophys. Res. (USA), Vol. 66, No. 7, 2105-111 (July, 1961).

Observations of the Australian National Antarctic Research Expedition at Wilkes in 1959 indicate two features of auroral behaviour similar to that observed at other stations on the poleward side of the isoaurore of maximum frequency: (1) diurnal variation of overhead occurrence exhibits evening and morning maxima, and (2) homogeneous auroras tend to be aligned in the sun—earth line. The observations do not indicate the existence of an inner auroral zone within the field of view of Wilkes station. Directions of transverse movement of auroras tend to be west-ward, but velocities are not accounted for by a simple orientation-fixed model.

21052 ELECTRIC CURRENTS ASSOCIATED WITH GEOMAGNETIC DISTURBANCES IN THE AURORAL ZONE.
F.J.Scrase.

Nature (GB), Vol. 191, 963-6 (Sept. 2, 1961).

Describes some preliminary results obtained from observations of the magnetic field at groups of three observatories spaced such that two subsidiary stations were 20 km from the main station in directions at right angles. The disturbances selected were mostly those of the bay-type of a few hours duration. The direction, strength and height of the disturbance currents were determined, and an attempt to relate the current strength to the velocity of auroral motion led to an electron density of $1.5 \times 10^7\,\mathrm{cm}^{-3}$ in the auroral stream. D.M.Schlapp

21053 BALLOON OBSERVATIONS OF AURORAL-ZONE X-RAYS. R.R.Brown.

J. geophys. Res. (USA), Vol. 66, No. 5, 1379-88 (May, 1961).

A series of balloon flights launched from the vicinity of College, Alaska, during June and July 1960 show that auroral-zone X-rays are detectable with Geiger counters approximately 10% of the time at pressure altitudes in the range 10-15 mb. The results of these flights indicate that the daily flux of electrons with energies greater than 50 keV over the auroral zone is 6×10^{10} particles cm^{-2}. Late in a magnetic storm that started with a sudden commencement at 1701 UT on July 14, 1960, the average electron influx exceeded the daily rate by more than a factor of 25.

21054 SCINTILLATION-COUNTER OBSERVATIONS OF AURORAL X-RAYS DURING THE GEOMAGNETIC STORM OF MAY 12, 1959. P.D.Bhavsar.

J. geophys. Res. (USA), Vol. 66, No. 3, 679-92 (March, 1961).

Auroral X-rays were observed at 10 g cm^{-2} atmospheric depth over Minneapolis on May 12, 1959, with a balloon-borne NaI scintillation spectrometer in the energy range 22 to 263 keV. This event accompanied the low-energy solar cosmic rays that also produced some γ rays in the atmosphere. Energy spectra of the X-rays were obtained after correcting for the presence of these γ rays. The peak in the auroral X-ray intensity was found to be associated with the passage of the aurora at the zenith. The electron spectrum responsible for the X-rays was determined and found to be in agreement with the observations on the electron spectrum of the outer radiation belt.

21055 ON THE EXCITATION OF THE FIRST POSITIVE N_2 BANDS IN AURORAE. A.Omholt.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 217-19 (March, 1961).

The excitation of the First Positive N_2 bands in aurorae may well be explained by the process

$$N_2(X^1\Sigma) + e \rightarrow N_2(B^3\Pi) + e. \tag{1}$$

Other processes, such as

$$N_2^+ + O^- \text{ (or } O_2^-) \rightarrow N_2(B^3\Pi) + O \text{ (or } O_2) \tag{2a,b}$$

have also been thought to be operative. Processes (2a,b) should give a time delay, not less than 1 sec, between the ionization process and the emission of quanta in the First Positive system. It should be possible to observe the corresponding time delay between the emission of the First Negative N_2^+ band and the First Positive bands when the aurora varies rapidly in intensity. With process (1) the time delay should be very small, since the N_2^+ bands almost certainly are excited simultaneously with the ionization, the two excitation processes being almost simultaneous. In order to clarify this problem the intensities of the First Positive N_2 bands and the First Negative N_2^+ bands emitted simultaneously from aurorae were recorded with a photoelectric two-colour filter photometer. The (0, 1) Negative band (λ = 4278 A) and the (5, 2) Positive band (λ = 6710 A) were isolated with multilayer interference filters (centred at 4278 and 6690 A, half-widths ~ 50 A), and recorded by photomultipliers. The photometer covers a circular field of diameter ~ 0·8°. The intensity fluctuations of the two emissions were recorded with a pen recorder and, when rapid fluctuations occured, with an oscilloscope fitted with a film camera. Records were obtained of all kinds of variable aurorae, including type B. The records show clearly that the two measured bands fluctuate in phase, and that there is no detectable, systematic time delay between the two emissions, even in rapidly fluctuating and pulsating aurorae. Since the processes (2a, b) definitely must give an appreciable delay, process (1) is probably the dominating one in exciting the First Positive bands.

21056 EXCITATION OF HELIUM IN THE AURORA.

J.M.Malville.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 1, 54-64 (April, 1961).

The populations of the excited levels of a helium atom traversing the atmosphere with an original energy of 256 keV are calculated using the method of statistical equilibrium. Because of the present inadequate knowledge of helium cross-sections, the calculations are only an exploratory approach toward the problem of helium in aurorae. It is estimated that each 256 keV helium particle produces 450 photons of λ10830 and 40 photons of λ5876 during its passage through the atmosphere. The profile and luminosity curve of λ5876 and λ10830 are predicted. Observational data of helium emissions are discussed.

21057 THE RELATIVE INTENSITIES OF SOME NITROGEN BANDS IN AURORAL SPECTRA.

M.Gadsden.

J. atmos. terrest. Phys. (GB), Vol. 22, No. 2, 105-21 (Oct., 1961).

Published measurements of the relative intensities of the nitrogen second positive bands emitted from aurorae are reviewed and are found to be reasonably consistent with electron excitation of either neutral or ionized nitrogen molecules. Details of measurements made from a station, Scott Base, well within the southern auroral zone are presented and discussed. The measurements indicate clearly that electron excitation cannot be the main cause of the second positive emission observed fron this station. An ionic charge exchange reaction is examined and appears likely to give rise to the population rates observed. Some consequences of the occurrence of this reaction are discussed, including the requirement that the electron density is very low during polar blackouts in regions of the atmosphere at or above the E-region.

21058 A METHOD OF ESTIMATING IONOSPHERIC ABSORPTION HEIGHTS FROM RECOVERY TIMES.

S.Ziauddin.

Nature (GB), Vol. 191, 1084-5 (Sept. 9, 1961).

A method is suggested for estimating the heights of the regions responsible for abnormal absorption of the kind associated with auroral disturbances. It uses the measurement of the relaxation time with which cosmic noise at 30 Mc/s returns to a normal level after a disturbance, and assumes that the ionizing agency ceases to operate at the instant of peak absorption. Heights deduced by this method agree with those determined by a three-frequency riometer method. D.M.Schlapp

A NEW METHOD FOR PRODUCING THE AURORAL AFTERGLOW OF NITROGEN AND ITS SPECTRUM. See Abstr. 17310

21059 AURORAL RADAR OBSERVATIONS AT 48 Mc/s DURING THE PERIOD OF THE 12 NOVEMBER 1960 SOLAR EVENT.

A.G.McNamara.

Canad. J. Phys., Vol. 39, No. 4, 619-21 (April, 1961).

Details are given of the occurrence of auroral echoes at three Canadian stations and of meteor echo counts, following two S.C. magnetic storms. The meteor effect is interpreted as caused by a widespread polar cap absorption event, and it is pointed out that this can also significantly alter the detection capabilities of v.h.f. auroral radar. Caution is therefore necessary in interpreting the auroral results in terms of variations in geographical distribution of reflecting ionization. G.M.Brown

21060 AURORAL RADIO-ECHOES AND MAGNETIC DISTURBANCES.

C.D.Watkins.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 131-9 (March, 1961).

It is shown that the probability of detecting auroral radio-echoes with a low sensitivity equipment at Jodrell Bank increases with the value of the magnetic K-index, being 100% for local K-indices of 8 and 9. There is a close correlation between east—west moving echo regions crossing the meridian of Eskdalemuir, Scotland and magnetic disturbances recorded there. A comparison of magnetograms obtained at Lerwick and Eskdalemuir (north and south of the echo regions respectively) show that, in general, during the occurrence of echoes, the current systems giving rise to the magnetic disturbance are situated south of Lerwick and north of Eskdalemuir and thus near the echo regions. An investigation of the location of visual auroral forms during the occurrence of echoes shows that they also are mainly situated in this region. The results confirm the suggestion of Bullough et al. (1957) that magnetic disturbances are closely related to regions of ionization which move approximately along magnetic parallels of latitude and which can be detected with radio echo equipments.

21061 TEMPORAL VARIATIONS OF AURORAL RADIO-ECHO ACTIVITY IN SUB-AURORAL LATITUDES.

C.D.Watkins

J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 140-8 (March, 1961).

Low power radio-echo equipments have been continuously operated for several years recording observations of auroral ionization. The results were examined for the following temporal variation of activity: diurnal, 27 day, seasonal and 11 year. The time delay between the occurrence of class 3 solar flares and subsequent echo activity has also been investigated. It is suggested that the bimodal diurnal distribution possibly arises from the condition of specular reflection which controls the detection of echoes and from the known north-south motions of visual auroral forms. The general features of the other periodicities are found to be little different from the well known ones of geomagnetic disturbance.

21062 A NOTE ON 106.1-Mc/s AURORAL ECHOES DETECTED AT STANFORD FOLLOWING THE SOLAR EVENT OF NOVEMBER 12, 1960.

R.L.Leadabrand, W.E.Jaye and R.B.Dyce.

J. geophys. Res. (USA), Vol. 6, No. 4, 1069-72 (April, 1961).

The echoes allowed the transit time of the auroral particles from the solar disturbance to be determined (20 hr 5 min). A particularly rapidly moving echo (100 km/s) was detected during the display.

21063 LONG-DISTANCE ONE-HOP F_1 PROPAGATION THROUGH THE AURORAL ZONE.

L.H.Tveten.

J. geophys. Res. (USA), Vol. 66, No. 6, 1683-4 (June, 1961).

The existence of one-hop F_1 propagation through the auroral zone over a 4495 km path is described, and an example of a sweep-frequency record illustrating this F_1 mode is shown.

21064 THREE-FREQUENCY MEASUREMENTS OF AURORAL ABSORPTION.

S.Ziauddin and P.A.Forsyth.

J. geophys. Res. (USA), Vol. 66, No. 8, 2315-19 (Aug., 1961).

Measurements of the effective height of the regions responsible for v.h.f. radio wave absorption were carried out during auroral disturbances. The technique depends upon measurements of the cosmic noise level at three closely spaced frequencies using a single aerial with a very broad sensitivity pattern. The absorbing region is usually above 70 km in height except during intense disturbances when there is an interesting sequence of separate events which progress toward lower heights, sometimes apparently reaching a level as low as 50 km.

21065 THE ANALYSIS OF TRANSIENT MODES OF PROPAGATION ACROSS THE AURORAL ZONE.

B.J.Fulton and L.E.Petrie.

J. geophys. Res. (USA), Vol. 66, No. 8, 2321-7 (Aug., 1961).

A model of propagation by scatter and ionospheric reflection is proposed to explain transient modes of propagation across the auroral zone. The parameters of the trace that is identified as a transient mode on sweep-frequency oblique-incidence records are used to calculate the position of the irregularity or cloud of ionization that acts as the scattering source. These parameters are also sufficient to establish the self-consistency of the model.

21066 DISTRIBUTION FUNCTION OF MAGNETICALLY CONFINED ELECTRONS IN A SCATTERING ATMOSPHERE.

W.M.MacDonald and M.Walt.

Ann. Phys. (USA), Vol. 15, No. 1, 44-62 (July, 1961).

A system of electrons confined in an inhomogeneous magnetic field in the presence of a nonuniform atmosphere of scattering particles is described at any instant by the distribution function appropriate to the situation in which no atmosphere is present. A generalization of the Fokker—Planck equation is then derived for the evolution in time of the distribution function through these quasi-equilibrium distributions. An approximate solution of this equation is given for the case of electrons trapped in the earth's magnetic field. This solution yields the distribution of the electrons in energy and angle as a function of time.

21067 DISCOVERY OF THE INNER RADIATION BELT AT 320 km ALTITUDE IN THE AREA OF THE SOUTH ATLANTIC MAGNETIC ANOMALY.

S.N.Vernov, I.A.Savenko, P.I.Shavrin and N.F.Pisarenko.

Dokl. Akad. Nauk. SSSR, Vol. 140, No. 5, 1041-4 (Oct. 11, 1961). In Russian.

Satellite observations of energetic particles are described. A rapid loss of particles from the radiation belts occurs in the inity of the anomaly; the situation of the anomaly, in relation to geomagnetic field, corresponds to the minimum between the er and outer radiation belts. [English translation in: Soviet ysics—Doklady (USA)]. H.Rishbeth

21068 RADIATION MEASUREMENTS TO 1500 KILOMETERS ALTITUDE AT EQUATORIAL LATITUDES.

E.Holly, L.Allen, Jr and R.G.Johnson.

geophys. Res. (USA), Vol. 66, No. 6, 1627-39 (June, 1961).

Three instrument packages containing Geiger tubes were flown o the inner Van Allen belt to altitudes up to 1500 km. Various sorber thicknesses were used to obtain range spectra for penetting particles. Magnetic separation of electrons and protons was rformed on counters with absorber thicknesses ranging from mg cm^{-2} of mica to 36 mg cm^{-2} of Al. The electron spectrum served with counters having electron energy thresholds of 30, 160, 0, and 460 keV appears considerably softer than a neutron beta-decay ectrum. Counts in counters with higher thresholds are assumed to be e to trapped protons and the measurements are compared with those tained with nuclear emulsion experiments on similar trajectories. solute flux values are reported.

21069 EFFECT OF HYDROMAGNETIC WAVES ON THE LIFETIME OF VAN ALLEN RADIATION PROTONS.

J.Dragt.

geophys. Res. (USA), Vol. 66, No. 6, 1641-9 (June, 1961).

The effect upon the motion of charged particles trapped in the omagnetic field is studied. Application is made to the proton mponent of the Van Allen radiation belt. It is shown, in agreeent with the suggestion of Welch and Whitaker (Abstr. 10430 of 60), that hydromagnetic waves of low frequency and amplitude are ble to account for the rapid decrease in proton flux that delimits e outer edge of the inner zone of the Van Allen radiation belt. oth the location of the boundary of the inner zone and the ratio etween the proton fluxes in the inner and outer zones are obtained. is found that, near 2 earth radii from the earth's centre, the aximum energy of the trapped protons decreases with geocentric stance as r^{-11}.

21070 CHARACTERISTICS OF THE VAN ALLEN RADIATION ZONES AS MEASURED BY THE SCINTILLATION OUNTER ON EXPLORER VI.

A.Rosen and T.A.Farley.

geophys. Res. (USA), Vol. 66, No. 7, 2013-28 (July, 1961).

A scintillation counter responding principally to direct lectrons was flown on the Explorer VI earth satellite in an lliptical orbit extending to 48 600 km. The instrument measured uxes of electrons above 200 keV and protons above 2 MeV. After week of magnetically quiet observations, a geomagnetic storm ccurred, and an immediate increase in the counting rate of this nstrument was detected; other radiation instruments showed a ecrease in counting rate at this time. Gross fluctuations in particle ntensity were observed at the edge of the outer zone of the Van Allen adiation belt during the storm, and these fluctuations are closely elated to simultaneous geomagnetic activity. The increased particle ntensity in the outer zone declined quite slowly after the storm until he next period of magnetic activity about two weeks later. This aper presents a detailed summary of the observations made by the cintillation counter during the period of data reception from the atellite.

21071 ENERGY SPECTRUM OF ELECTRONS TRAPPED IN GEOMAGNETIC FIELD.

M.Walt and W.M.MacDonald.

J. geophys. Res. (USA), Vol. 66, No. 7, 2047-52 (July, 1961).

A Fokker—Planck equation for the distribution function of electrons trapped in a magnetic field in the presence of a scattering atmosphere is applied to the Van Allen electron belt. Solutions are obtained for the equilibrium flux resulting from an electron source of arbitrary energy for the cases where (a) loss of energy by collisions is neglected, and (b) loss by diffusion out of the trapping region is neglected; and an approximate solution is obtained for the actual case where both processes are important. The assumption that the electron source is supplied by decaying neutrons leads to an equilibrium electron flux whose energy dependence is qualitatively different from the observed spectrum.

21072 RING CURRENTS IN THE REGION OF THE VAN ALLEN RADIATION BELTS.

R.Fiebig and H.Voelcker.

J. geophys. Res. (USA), Vol. 66, No. 7, 2262 (July, 1961).

A summary of the results of theoretical calculations of the strengths of the ring currents, treating the radiation belts as a plasma contained by the earth's magnetic field. The results agree satisfactorily with observations, in view of the uncertainty of the measured values. D.M.Schlapp

21073 INTENSITY VARIATIONS IN OUTER VAN ALLEN RADIATION BELT.

S.E.Forbush, D.Venkatesan and C.E.McIlwain.

J. geophys. Res. (USA), Vol. 66, No. 8, 2275-88 (Aug., 1961).

Using data from Explorer VII, the changes in the intensity of the outer Van Allen radiation belt were investigated in detail over the period October 26, 1959 to December 9, 1959. To relate the intensities to location in the belt, the parameter L was used. L is defined as a function of the integral invariant I and scalar magnetic field B, such that everywhere on the shell described by the motion of a trapped particle in the earth's magnetic field, L closely approximates the equatorial radius of the shell. For the period under study, the intensity variations at selected values of L were negatively correlated with geomagnetic activity. However, an analysis of data over a much longer period is required to determine whether this correlation is statistically significant. For the period studied, the decrease in measured intensity during periods of magnetic storms (large a_p) is consistent with the idea that some of the particles were "dumped" into the auroral and subauroral zones where they may partly contribute to the auroral zone currents that account for a_p. In addition, the reduction in intensity generally occurred in the outer part of the zone. The low values of intensity, for L = 3.5, 4.1 and 4.7, occurred in the interval November 22 to December 9, at times when the equatorial ring current field, U. (southward on the earth at the equator), was large. This, U cannot be due to the westward current due to the longitudinal drift of measured trapped particles in the region for which L is greater than 3.5, since a decrease in particle density therein would diminish the westward drift current with a consequent decrease in U, which is opposite to what is observed. This result indicates that the site of the ring current is either elsewhere, or that the principal contribution to it comes from drifting particles having energies below the detection thresholds of Explorer VII equipment. The phenomena were investigated over a longer period, using daily averages of the maximum counting rates, This procedure had serious limitations.

21074 SOME EFFECTS OF DIAMAGNETIC RING CURRENTS ON VAN ALLEN RADIATION.

A.J.Dessler and R.Karplus.

J. geophys. Res. (USA), Vol. 66, No. 8, 2289-96 (Aug., 1961).

The distortion of the geomagnetic field by diamagnetic ring currents (such as the magnetic storm main phase ring current) is calculated quantitatively. It is shown that these distortions cause changes in the energy of the trapped electrons in the outer zone of the Van Allen radiation belt. The changes are brought about by betatron acceleration and deceleration of the trapped radiation as the distortions move the radiation from one field strength region into another. A model is presented involving a system of two diamagnetic ring currents for which there is some observational evidence. In this model part of the geomagnetic storm energy is temporarily transferred to the Van Allen radiation. It is proposed that such a mechanism contributes, in part, to the major fluctuations in the observed intensities of the outer zone of the radiation belt because (1) the changes in particle energy cause changes in the counting rate of radiation instruments flown through the belt, and (2) the Van Allen electron number density is a steep function of radial distance so that distortions of the geomagnetic field can cause changes in particle flux.

21075 ENERGY SPECTRUM AND ANGULAR DISTRIBUTIONS OF ELECTRONS TRAPPED IN THE GEOMAGNETIC FIELD.

J.B.Cladis, L.F.Chase, Jr, W.L.Imhof and D.J.Knecht.

J. geophys. Res. (USA), Vol. 66, No. 8, 2297-312 (Aug., 1961).

The energy spectrum and the pitch-angle distribution of the electrons near the lower edge of the outer radiation zone were measured by means of a collimated magnetic-deflection spectrometer carried in a Javelin rocket. The rocket was launched from Wallops Island, Virginia, and reached an altitude of 1045 km. Along the ascent trajectory, the rocket followed closely a geomagnetic line of force, permitting measurements of the electron flux to be made along the reflection points of the electrons, The pitch-angle distributions of the electrons were found to be symmetrical about 90° and to have widths that increased as the rocket moved up the magnetic field line. The widths of these distributions at half-height were found to be 31.2° at 750 km and 41.6° at 920 km. The spectrometer data yield a spectrum which can be fitted well by the form

$$E^{p} \exp(-qE), \text{ where } p = 1.60^{+0.74}_{-0.44}, q = 0.022^{+0.0025}_{-0.0019} \text{ keV}^{-1},$$
$$\text{for } E > 50 \text{ keV}.$$

Within the accuracy of the measurements, no change in spectrum shape was observed at altitudes greater than about 600 km. At apogee the omnidirectional intensity of electrons of energies greater than 50 keV was found to be $4.2 \pm 0.8 \times 10^{6}$ electrons cm^{-2} sec^{-1}.

21076 THE OBSERVED OUTER-BELT ELECTRON DISTRIBUTION AND THE NEUTRON DECAY HYPOTHESIS.

W.N.Hess, J.Killeen, C.Y.Fan, P.Meyer and J.A.Simpson.
J. geophys. Res. (USA), Vol. 66, No. 8, 2313-14 (Aug., 1961).

Measurements of electron flux along a line of force in the outer radiation belt are compared with calculations that assume that all electrons are injected by neutron decay. The comparison shows that the two distributions are quite different at intermediate and low latitudes where corrections are unimportant. It is concluded that other processes, in addition to electron injection by neutron decay, are necessary to explain the experimentally observed flux distribution along a line of force.

21077 DYNAMICS AND STRUCTURE OF THE OUTER RADIATION BELT.

C.Y.Fan, P.Meyer and J.A.Simpson.
J. geophys. Res. (USA), Vol. 66, No. 9, 2607-40 (Sept., 1961).

From an analysis of electron measurements in the Explorer VI satellite (August 7-October 6, 1959) four time-dependent parameters which characterize the outer electron belt are investigated. They are: (1) the equatorial electron intensity I_0; (2) the equatorial range from the earth R_0 of the peak intensity; (3) the electron-density distribution along a line of force through the intensity peak; and (4) a measure of the change in electron spectrum with time. These parameters, along with measurements of magnetic field intensity, make it possible to study the origin of the changes in electron intensity and distribution which are known to occur in the outer belt. Several magnetic storms occurred during the observation on Explorer VI. Within the sequence of changes in the outer belt induced by these geomagnetic storms, there are some changes of the parameters which are accounted for only by invoking an irreversible energy gain or loss within the outer belt. The energy gain process appears to be through irreversible local acceleration of electrons. The energy loss process leads to a stable mirror-point distribution characteristic of the periods between geomagnetic storms. The time intervals within which each of these processes is operative are identified. Reversible processes are possibly the cause for other changes. The foregoing analysis rests upon the proof given in this paper that the outer-belt peak intensity coincides over a wide range of geomagnetic latitudes with magnetic field lines of force in the centred dipole approximation. Consequently, the measured electron-intensity maximum is used as a "tracer" of the geomagnetic field lines of force for analysing changes in the outer belt with time. It is shown that even during geomagnetic storms the trace of the electron-intensity maximum followed a centred dipole line of force. This indicates that at all times the particle-energy density of the radiation belt is much less than the energy density of the magnetic field in the region. The electron fluxes, high-energy proton fluxes, and possible electron spectra are investigated. Two distinct peaks of electron intensity are identified to persist in the outer belt for about 2 months, and it is shown that these peak distributions undergo radial motion during geomagnetic disturbances.

21078 THE DISTRIBUTION OF TRAPPED PARTICLES IN A CHANGING MAGNETIC FIELD.

E.N.Parker.
J. geophys. Res. (USA), Vol. 66, No. 9, 2641-52 (Sept., 1961).

The redistribution of charged particles in the mirror field

$$B(s,t) = B_0 T(t)\{1 + [s/a(t)]^{\nu(t)}\}$$

is worked out for slow changes in $T(t)$, $a(t)$, and $\nu(t)$. It is found that increasing $T(t)$ gives a relatively greater particle density increase in the centre of the field than deep in the mirrors $s \gg a(t)$. The mirror distance retracts like $1/T^{1\neq(\nu+2)}$. Decreasing $a(t)$ has the opposite effect. Field variations constrained to preserve $T(t)\,a^{2}(t)$ and $\nu(t)$ leave the form of the particle distribution unchanged, increasing the density everywhere by the same factor.

21079 A THEORETICAL MODEL OF ELECTRON DENSITY DISTRIBUTION ALONG A GEOMAGNETIC LINE OF FORCE IN THE EXOSPHERE.

R.L.Dowden.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 122-30 (March, 1961).

By consideration of charged particles spiralling in geomagneti tubes of force, particle densities are derived for a source of particles filling the tubes at (i) the equatorial plane or (ii) the earth's surface (ionosphere). The first case gives a distribution o roughly constant density for geomagnetic latitudes (λ) up to 60° an the second to one of density roughly proportional to magnetic field strength for $\lambda < 60°$ and $R < 1.25$ earth's radii.

21080 CORPUSCULAR RADIATIONS IN SPACE.

J.A.Van Allen.
Radiation Research (USA), Vol. 14, No. 5, 540-50 (May, 1961).

Discusses the present state of knowledge of the energetic particles trapped in the magnetic field of the earth. The nature and origin of the trapped radiation are briefly discussed. Radiatio exposure levels in the inner and outer zones are given and the possible radiation hazards of space flight are examined in detail.

C.F.Barnab

21081 PRODUCTION OF ATMOSPHERIC NEUTRONS BY SOLAR γ RAYS.

K.Maeda.
Nuovo Cimento (Italy), Vol. 20, No. 3, 587-90 (May 1, 1961).

Estimates the contribution of high-energy solar γ-rays, shoul any exist, to the phenomenon of neutron intensity transition in the upper atmosphere found by Haynes (Abstr. 2610 of 1960) during sunset balloon experiments. The considerations involved are: the increase in penetration depth of solar γ-rays during sunset and the diffusion of slow neutrons in air, simplified by Fermi's ageing factor. The calculation assumes an integral cross-section for photoneutron production in air of 0.5 MeV barn, taking into account an additional photoneutron production mechanism for γ-rays > 100 MeV given by $N^{14} + \gamma \rightarrow 3\,He^{4} + p + n$. Curves are given for the neutron yield in air for various energies of incident photons, and also for the relative intensity of photoneutrons in the upper atmosphere (calculated) as compared with the experimentally observed transition curve. These show that the observed maximum intensity of slow neutrons can be explained by 300 MeV solar γ-rays, but the atmospheric depth corresponding to the observed transition maximum 140 g cm^{-2}, is difficult to ascribe to γ-ray cascades, unless the primary solar γ-ray is assumed to exceed several GeV, though, since the variation of penetration depth of solar radiation is very fast at the time of large zenith angle of the sun, the apparent discrepancy does not invalidate the argument.

M.Kash

GEOMAGNETISM

THE STEADY STATE OF THE CHAPMAN—FERRARO PROBLEM IN TWO DIMENSIONS. See Abstr. 16538

GEOMAGNETISM IN RELATION TO AERONOMY. See Abstr. 21083

21082 INTRODUCTION TO GEOMAGNETISM: THE EQUATORIAL ELECTROJET.

M.Casaverde.
Amer. J. Phys., Vol. 29, No. 11, 744-53 (Nov., 1961).

The fundamentals of the measurement of the earth's magnetic field are described. Its general form is approximated to the field of a theoretical dipole magnet. The solar daily type (S) of transien variation in the geomagnetic field depends on the solar activity, the seasons, geographical latitude, and local time. At Huancayo Magnetic Observatory the abnormally high daily variation of the horizontal component of the field at the magnetic equator was discovered; it is confined to a narrow belt around the magnetic equator due to an induced effect of the equatorial electrojet. This equatorial electrojet is an eastward flowing current in the atmosphere at about 100 km altitude, some 660 km wide, with a measure maximum current density as high as 140 amp/km of width, for a given time. The theory of the origin of the electrojet, developing from an increase in atmospheric conductivity at the equator and nds at high latitudes, is described. Finally, the quiet-day solar ly variation in the vertical component of the geomagnetic field the magnetic equatorial region in Peru is presented tentatively a combined effect of the normal upper atmospheric current w and the electrojet. A bibliography is included.

21083 GEOMAGNETISM IN RELATION TO AERONOMY.
E.H.Vestine.

n. Geophys. (France), Vol. 17, No. 2, 181-94 (1961).

The geomagnetic field and its time fluctuations, which are of terest to aeronomy, are described. The theories that have been ought forward to explain these fluctuations are reviewed. The le of upper air winds in producing the solar and lunar daily magnetic variations, and that of charged energetic particles in causing omagnetic disturbance are indicated. The response of geomagnetically trapped radiation in the Van Allen belts and adjacent regions geomagnetic field changes is discussed. The use of integral invariants in predicting certain auroral effects and especially the explanation of auroral isochasms is also reviewed. Finally, mention made of the early findings of rocket probes penetrating nearby ace.

21084 MAGNETIC DISTURBANCES AND THE EARTH'S MAGNETIC FIELD.
J.S.Chatterjee.

geophys. Res. (USA), Vol. 66, No. 5, 1535-46 (May, 1961).

An attempt is made to explain the origin of the observed agnetic field of the earth as being due to a current system rculating in the core, the current system in its turn being maintained by world-wide magnetic disturbances. The mantle behaves a semiconductor, and the conduction electron density is given by e Boltzmann distribution law. The conductivity changes steeply ong the radial direction, and a "potential hill" is produced in is direction. Owing to interaction of the induced current with the eady magnetic field, a Hall potential is developed; this modifies e existing "potential hill", and hence the conductivity becomes to ome extent dependent on the induced current vector. The consequent nonlinearity rectifies the induced current, and a net amount of nidirectional current aiding the existing magnetic field is left over the end of the disturbance. This gradually penetrates down to the ore and has a decay time of the order of a million years. The net nidirectional current then grows through successive disturbances. is shown that, for reasonable values of conductivity, temperature, nd electron mobility, the magnetic disturbances maintain a ufficiently large current in the core for the earth's magnetism to e explained as entirely due to the magnetic disturbances.

GEOMAGNETIC DECELERATION OF THE ROCKET-CASE OF PUTNIK III. See Abstr. 18227

21085 A NEW TEST OF THE HYPOTHESIS OF THE NATURE OF THE MAGNETIC DECLINATION.
V.Shuleikin and N.I.Sigachev.

Dokl. Akad. Nauk SSSR, Vol. 140, No. 1, 107-10 (Sept. 1, 1961).
n Russian.

A new apparatus is described, intended to be towed by a ship t depths to over 4000 m in the sea. It consists of a two-chambered ontainer with a gyro-compass in one compartment and a magnetic ompass in the other. The two are geared to a registering device o that the magnetic declination can be recorded directly. A figure hows the arrangement of various components in the two compartments. Another diagram exhibits typical graphs obtained at various depths in the Atlantic. The elementary theory is given of the measurement of the change in declination as the apparatus is moved rom one depth to another. On descending from the surface of the sea, there proves to be practically no change in declination to depths of 500 m, very little to depths of 900 m, but thereafter great changes occur. At 4200 m, the change from the surface value is a decrease of about 24°. This is in agreement with the theory that electric currents in the oceans are responsible for the latitudinal component of the earth's magnetic field, and therefore for the declination.

N.Davy

21086 ROCKET MEASUREMENTS OF THE MAGNETIC FIELD ABOVE NEW MEXICO.
R.Hutchinson and B.Shuman.

J. geophys. Res. (USA), Vol. 66, No. 9, 2687-93 (Sept., 1961).

Absolute value, total intensity measurements of the magnetic field above Holloman Missile Development Centre, New Mexico, were obtained to an altitude of 236 km with a proton precession magnetometer aboard an Aerobee-Hi rocket. The flight took place on a magnetically quiet day during the normal midmorning variation. Comparison of the observed values with those predicted by spherical harmonic coefficients yields an anomaly of the order of 80 γ during ascent between the altitudes of 85 and 165 km, whereas no comparable effect was found for the descent portion of the flight down to 146 km.

21087 EFFECT OF HYDROMAGNETIC WAVES IN A DIPOLE FIELD ON THE LONGITUDINAL INVARIANT.
E.N.Parker.

J. geophys. Res. (USA), Vol. 66, No. 3, 693-708 (March, 1961).

Hydromagnetic wave violation of the longitudinal invariant of a particle trapped in a mirror magnetic field is investigated quantitatively. It is shown that the passage of hydromagnetic waves across the region of mirroring leads to a diffusion of the individual-particle mirror points. If the relative wave amplitude $\Delta B/B$ is maintained throughout the mirror field, particles released in the field will soon diffuse out through the mirror and be lost. Application to thermonuclear devices is obvious. Confining attention principally to the charged particles trapped in the geomagnetic field, it is shown that high-energy (10^5 eV) electrons in the outer Van Allen radiation zone are caused to diffuse along the lines of force with a characteristic time of 4 months by hydromagnetic waves of 1 c/s and an amplitude of 10^{-4} G. Hydromagnetic diffusion appears to be more important than collisions in determining the electron lifetime and distribution in the outer Van Allen radiation zone. Different wave distributions along the lines of force can give radically different particle distributions. It is shown that, if the hydromagnetic disturbances extend throughout the geomagnetic field, then, rather than yielding particle acceleration, they result in a net loss of particle energy. But if it is assumed that a region of hydromagnetic disturbance is localized inside the geomagnetic field, limited particle acceleration may result.

21088 CALIBRATION OF PULSATION DETECTOR COILS.
K.Vozoff.

J. geophys. Res. (USA), Vol. 66, No. 6, 1983-4 (June, 1961).

Attention is drawn to the possibility of error in calibrating magnetic micropulsation detectors due to neglect of eddy-current effects. An expression for the field is derived taking these into account. It is shown that their neglect leads to a percentage calibration error of $\epsilon = [1 - (A^2 + B^2)]^{1/2} \times 100$, where A and B are the real and imaginary components of the reduced field. For normal values of conductivity, and a loop of 100 metres radius, the error is less than 1% up to frequencies of the order of 100 c/s.

S.A.Ahern

21089 THE RING CURRENT, GEOMAGNETIC DISTURBANCE, AND THE VAN ALLEN RADIATION BELTS.
S.Akasofu and S.Chapman.

J. geophys. Res. (USA), Vol. 66, No. 5, 1321-50 (May, 1961).

The large decrease in the horizontal component of the earth's field during the main phase of magnetic storms was ascribed to the formation or enhancement of a geomagnetic ring current. The motions of particles trapped in the earth's dipole field and the resulting ring current is discussed. These calculations deal only with a steady state, though during storms the state is changing. The general equations for the current intensity, to obtain the total current and the magnetic field at the earth's centre, are applied to the outer radiation belt (V_2) and to a special "model" belt V_3. This V_3 belt has a particular type of pitch—angle distribution and a number—intensity distribution of Gaussian type along an equatorial radius. The results are considered in connection with magnetic records for several storms and with satellite data. It is infered that, during a magnetic disturbance, protons of energy of the order of a few hundred keV are intermittently captured between 5 and 8 earth radii and that they produce a transient belt V_3. The variety of development of the ring current from one storm to another may be connected with irregularities in the distribution of particles in the solar stream, which may contain tangled magnetic fields.

21090 SOME STUDIES OF GEOMAGNETIC MICROPULSATIONS.
R.A.Duncan.

J. geophys. Res. (USA), Vol. 66, No. 7, 2087-94 (July, 1961).

Oscillations of the geomagnetic field with periods between 1 second and a few minutes were studied by means of large ground loops at Hobart, Adelaide, Camden, and Townsville, Australia. Records were made both on charts and on slowly moving magnetic tape; the tape recordings were analysed for frequency components on a "Sonagraph" sound spectroscope. The period of the continuous oscillations known as Pc's showed a diurnal variation and a marked dependence on latitude, shorter periods occurring at lower latitudes. The damped trains of oscillations, occurring predominantly around local midnight, known as Pt's were followed by magnetic bays with an average delay of about 15 min. During storms, "sweepers" — oscillations with a progressive change of frequency and sometimes with aharmonic overtones — were observed.

21091 THE DIURNAL VARIATION OF K INDICES OF GEOMAGNETIC ACTIVITY ON DISTURBED DAYS IN 1940-1948. S.B.Nicholson and O.R.Wulf.

J. geophys. Res. (USA), Vol. 66, No. 8, 2399-404 (Aug., 1961).

From the eight daily K numbers for the 5 disturbed days of each month in the 9 years 1940-1948 from six observatories in moderately low latitudes, local- and universal-time components of the diurnal variation of these K indices were computed. The local-time component shows no pronounced seasonal change. It has a maximum near 21 hrs. The separate yearly average for each of the 9 years shows a fairly regular change in amplitude over these years. The change is particularly marked from 1943 to 1947, and is of such character as might be occasioned by an increase over this interval in a separate local-time component having a daytime maximum. Its occurrence over these years suggests that it may be related to the solar cycle. The universal-time component shows a pronounced seasonal change. When it is examined as the yearly average for each of the 9 years separately, although large differences from year to year are found, apparently in considerable measure at random, nevertheless there appears to be a significant yearly average.

21092 A FEATURE OF NOCTURNAL MAGNETIC ACTIVITY AT THE DUMONT D'URVILLE STATION (ADELIE LAND). A.Lebeau.

C.R. Acad. Sci. (France), Vol. 253, No. 9, 1094-6 (Aug. 28, 1961). In French.

During the period, April to December 1957, a total of 109 night-time "bays" was recorded on the H-magnetograph installed at this station for the IGY programme. These "bay" features are associated with a vector displacement of the horizontal geomagnetic component in a direction opposite to that of the sun as seen from the centre of the S auroral zone. The direction agrees with that observed for the circumzenithal auroral arcs (Weill, 1958).

D.R.Barber

21093 CRITICISM OF THE THEORY OF MAGNETIC BAYS OF BLESS, GARTLEIN, KIMBULL AND SPRAGUE. K.D.Cole and F.R.Bond.

J. geophys. Res. (USA), Vol. 66, No. 1, 327 (Jan., 1961).

As the ionosphere is not electrically homogeneous, any net transport of charge must produce electric polarization fields, and these will give rise to current systems different in pattern from the currents produced by the transport of positive ions by neutral winds in the homogeneous atmosphere which is the basis of the theory of magnetic bays by the four authors referred to in the title. To account for the observed relations between magnetic bays and aurora Cole has published (Abstr. 1588 of 1961) a theory which predicts movements of electrons at speeds about ten times greater than neutral wind speeds. J.M.Stagg

21094 GEOMAGNETIC CROCHET OF 15 NOVEMBER 1960. M.Yasuhara and H.Maeda.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 4, 289-93 (July, 1961).

Study of the unusually great geomagnetic crochet associated with the class 3+ solar flare at 0221 hours on 15 Nov. 1960 has led to the conclusion that the electric currents responsible could not arise from a simple augmentation of the normal Sq currents. The observed bursts of solar radio emission in the cm range and the ionospheric s.i.d. associated with solar X-rays suggest that the geomagnetic crochet may have been caused by currents flowing mainly in the D-region. G.M.Brown

21095 AN IDEALIZED PROBLEM OF PLASMA DYNAMICS THAT BEARS ON GEOMAGNETIC STORM THEORY; OBLIQUE PROJECTION. S.Chapman and P.C.Kendall.

J. atmos. terrest. Phys. (GB), Vol. 22, No. 2, 142-56 (Oct., 1961).

A cylindrical sheet current distribution of neutral ionized gas is situated in a permanent unidirectional magnetic field whose intensity varies as an inverse power of the distance from the axis of the cylinder. Initially every particle is projected obliquely symmetrically inward with the same speed. The motion through the field generates an electric current around the sheet, and a uniform magnetic field within the space enclosed. The sheet is retarded by the interaction between the current and the magnetic field. If the charge of either sign per unit length of the cylinder exceeds a certain value the sheet remains one — otherwise it divides into a negative and a positive sheet. The motion in the former case, which bears on the geomagnetic deflection of solar particles travelling towards the earth, is studied in detail. It has some bearing on the theory of magnetic storms, and on the shape of the hollow carved by the eart field in solar streams, as investigated by Chapman and Ferraro (1941), and more recently by Beard (Abstr. 15358 of 1961), Dungey (Abstr. 16538 of 1961), Zhigulev and Romishevskii (Abstr. 13499 of 1959) and other writers.

21096 CONNEXION BETWEEN MICROPULSATIONS AND THE IONOSPHERE. C.M.Lock and P.J.Stevens.

Nature (GB), Vol. 191, 584-5 (Aug. 5, 1961).

Simultaneous recording of geomagnetic micropulsations at two widely spaced stations (6750 km) which are not geomagnetically conjugate shows that the Pt type disturbance occurs simultaneously at the two stations whilst oscillations of the Pc type, although occurring at approximately the same time, do not exhibit the same coherence. Coherence between Pc start-up time and sunrise has been found, th effect being latitude-dependent. Finally the generation of the two types of disturbance is considered. D.Llanwyn-Jones

21097 SOME FEATURES OF MAGNETIC STORMS IN HIGH LATITUDES. D.G.Knapp.

J. geophys. Res. (USA), Vol. 66, No. 7, 2053-85 (July, 1961).

During a severe magnetic storm, observatory records obtained in high latitudes may show a type of disturbance called a "cusped bay", characterized by a marked displacement of the trace, coupled with augmented short-period fluctuations. Several of these events registered during the IGY at stations near the northern and southern auroral zones, some with amplitudes approaching 2000 γ, were measured on all appropriate magnetograms and plotted on maps as equivalent overhead current vectors. They show some of the characteristics of systems based on hourly-value changes during storms. However, they afford almost no evidence of the afternoon eastward segment of the auroral electrojet, and the polar cap effects are indicative of patterns having greater complexity tha the one usually ascribed to this region. The author recommends the study of cusped bays as a supplement to the use of hourly values an a means of probing details of magnetic activity that are difficult to approach in other ways. A catalogue of IGY storms is appended to the paper.

21098 A POSSIBLE EXPLANATION OF S.C.* OBSERVED AT HIGH GEOMAGNETIC LATITUDES. T.Ondoh.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 4, 284-6 (July, 1961).

A model is developed in which the main impulse of SC* at high latitudes is attributed to hydromagnetic waves, generated by the impact of the solar plasma on the geomagnetic field on the noon meridian plane, propagating along the geomagnetic lines of force to the earth's surface. The ordinary SC at low latitudes is considered to be produced by other hydromagnetic waves propagating obliquely or perpendicular to the geomagnetic lines of force. The preliminar reverse impulse of SC* is attributed to a dynamo action of ionizatio due to high-speed particles impinging on the high-latitude ionosphere, or to an initial diamagnetic effect due to the particles spiralling round the lines of force. G.M.Brow

GEOMAGNETIC DISTURBANCES FROM JULY 1957 TO JULY 1958, AND THEIR CORRELATION WITH SOLAR RADIO BURSTS. See Abstr. 16926

SOLAR CORPUSCULAR STREAMS AND GEOMAGNETIC FIELD IN JULY 1959. See Abstr. 18084

THE JULY 1959 EVENTS AND ASSOCIATED PHENOMENA. See Abstr. 18085

SOLAR RADIO EMISSIONS AND GEOPHYSICAL DISTURBANCES DURING JULY 1959. See Abstr. 18167

MAIN CHARACTERISTICS OF PULSATIONS OF THE EARTH'S ELECTROMAGNETIC FIELD IN JULY 1959. See Abstr. 20860

X-RAYS ACCOMPANYING THE MAGNETIC STORM OF JUNE 27, 1960. See Abstr. 20947

SMALL-SCALE POLAR-CAP ABSORPTION AND RELATED GEOMAGNETIC EFFECT. See Abstr. 20942

THE GEOMAGNETIC STORM EFFECT ON POLAR CAP ABSORPTION. See Abstr. 20946

21099 THE EFFECT OF THE OCEAN ON RAPID GEOMAGNETIC CHANGES.

T.Rikitake.

Geophys. J. (GB), Vol. 5, No. 1, 1-15 (May, 1961).

With the aid of two-dimensional experiments and mathematical theory, the electromagnetic induction in a conductor covered by a conducting sheet is studied. Applying the results to the effect of the ocean on rapid geomagnetic changes, it turns out that the previous estimate of the ocean effect based on the induction in a single sheet is an over-estimate. C.S.Cox's model (unpublished), by which he explained the anomaly of geomagnetic variations in Japan as the effect of the ocean at its margin, is also criticized. The writer is of the opinion, contrary to Cox, that the anomaly is likely to be caused by the induced electric currents at some depth in the earth's interior beneath Japan.

21100 THE CORRELATION OF RADIO STAR SCINTILLATIONS WITH GEOMAGNETIC DISTURBANCES.

B.H.Briggs.

Geophys. J. (GB), Vol. 5, No. 4, 306-17 (Oct., 1961).

The correlation between the degree of scintillation of the radio source Cassiopeia A and the local magnetic K-index is studied. It is shown that the correlation coefficient between these quantities depends upon the epoch of the solar cycle at which the observations are made, on the position of the source in the sky, and on the radio frequency used. For observations on 38 Mc/s made at sunspot minimum, the correlation coefficient is small but positive for all positions of the source. At sunspot maximum, the correlation coefficient is positive when the source is near upper transit and negative when it is near lower transit; the average value of the correlation coefficient for all positions of the source is approximately zero. It is shown that these results can be explained when the finite angular diameter of the radio source is taken into account. For some conditions an increase in the degree of irregularity of the ionosphere can result in a decrease in the degree of scintillation which is observed. It is suggested, therefore, that the degree of irregularity of the ionosphere always increases during magnetic disturbances in medium latitudes, and that the negative values of the correlation coefficient between scintillation index and magnetic K-index which are sometimes obtained are due to a secondary effect related to the finite size of the source. The results of the present paper explain the inconclusive and conflicting results of earlier workers.

21101 THE GROSS CHARACTER OF THE GEOMAGNETIC FIELD IN THE SOLAR WIND.

F.S.Johnson.

J. geophys. Res. (USA), Vol. 65, No. 10, 3049-51 (Oct., 1961).

The effect of a rapidly moving highly conducting solar plasma, or solar wind, on the earth's magnetic field should be to deform it and confine it; it should not be to pullout to infinity magnetic lines of force which otherwise would lie close to the earth. At low latitudes the geomagnetic field is strengthened by the interaction at all distances from the earth out to the confining boundary, beyond which there is solar plasma and no geomagnetic field. At high latitudes, however, the geomagnetic field is weakened by the confining action of the solar wind. The shape that the deformed geomagnetic field should assume is roughly that of a tear drop; the marked lack of symmetry in the deformed field must be an important factor in space investigations such as measurements of trapped radiation or geomagnetic field. The boundary between the geomagnetuc and the solar plasma should be turbulent; there is a possibility that the presence of the hydromagnetic waves generated by the turbulence will open the tail of the tear drop, thus modifying the confinement of the field by the solar wind.

21102 BRIGHT 21-CENTIMETER SOLAR REGIONS AND GEOMAGNETIC STORMS IN 1952-53.

R.T.Hansen.

J. geophys. Res. (USA), Vol. 65, No. 11, 3827-9 (Nov., 1960).

Diagrams show how the planetary geomagnetic indices Kp and Ap varied from 14 days before to 14 days after the 13 dates in the two years of central meridian position of the brightest solar regions at a wavelength of 21 cm as measured in Australia. On the average there was a sharp increase in the geomagnetic indices on the sixth day after the central meridian position of these bright regions. Six of these same 13 days were followed after 3 to 6 days by a storm as listed in the Greenwich geomagnetic storm data. The results suggest that decimetric radio emission from the sun may be a sensitive indication of the likelihood that an active solar region will be followed by a geomagnetic disturbance. J.M.Stagg

21103 CORRELATION BETWEEN SOLAR ACTIVITY AND SUDDEN MOVEMENTS IN GEOMAGNETIC DISTURBANCES.

H.Takahashi.

J. geophys. Res. (USA), Vol. 65, No. 12, 4206-9 (Dec., 1960).

The durations (Δt) and amplitudes (ΔH) of all the sudden commencements and impulses recorded in the horizontal component of the earth's magnetic field at Kakioka observatory in the years 1924-58 were measured and correlated with the Zurich number for solar activity (R). Diagrams show the variation of R against Δt, ΔH and $\Delta H/\Delta t$ and also the change of frequency distribution in the magnetic parameters with different groupings of sunspot number. The inferences from the diagrams, which are supported by numerical values of correlation coefficients, are that ΔH and $\Delta H/\Delta t$ are positively and Δt negatively correlated with solar activity. No physical explanation is offered. J.M.Stagg

21104 INTER-RELATION BETWEEN GEOMAGNETIC DISTURBANCES AND AURORAE DURING THE JULY 1959 EVENTS AT SYOWA STATION, ANTARCTICA.

T.Nagata and T.Oguti.

"July 1959 Events" Symposium, Helsinki, 1960 (see Abstr. 7988 of 1961) p. 108-13.

A detailed study of the relationships between geomagnetic sudden commencements, isolated geomagnetic bays, and the zenithal intensity of the auroral green line on the night-side of the earth. Examples are given of some giant geomagnetic pulsations with synchronous auroral pulsations. D.R.Barber

21105 SUPERPARAMAGNETISM IN RED SANDSTONES.

K.M.Creer.

Geophys. J. (GB), Vol. 5, No. 1, 16-28 (May, 1961).

Susceptibility measurements down to liquid-hydrogen temperatures were made on rocks with (a) unstable and (b) stable natural remanent magnetization. The former follow a Curie Law and this indicates that most of the magnetic content is apparently paramagnetic. Measurements in different fields fail to reveal the weak ferromagnetism responsible for the natural remanence. The latter measurements suggest that an apparent paramagnetic component is present together with a component having a susceptibility independent of temperature. In both cases the magnetization—applied field relationship at liquid-helium temperature in fields up to 20 000 Oe is not linear and this probably indicates that both rocks contain ferromagnetic material in a superparamagnetic state, the particle size of which is calculated to be of the order of 20 A. The material is thought to be hydrous alpha ferric oxide of which the cement is made. Viscous magnetization of about the same strength as the weak fossil remanence has previously been observed in the unstable rock but is not noticeable in low fields in the stable one. The remanent magnetization of red rocks is thought to be due in part to grains of the red cement larger than those responsible for viscous magnetization and superparamagnetism and in part to black haematite grains. These are sparsely distributed in the unstable rock but are more abundant in the stable one. Magnetization of the cement might occur soon after formation, or during a sintering process during burial at depth, or in some cases in geologically recent times due to tropical weathering. The calculated grain size of about 20 A for the superparamagnetic particles differs appreciably from that of about 1 000 A previously estimated for the viscous particles. Experiments are being made on artificially produced haematite of known particle size to resolve this anomaly.

21106 THE MEASUREMENT AND COMPUTATION OF ANISOTROPY OF MAGNETIC SUSCEPTIBILITY OF ROCKS.

R.W.Girdler.

Geophys. J. (GB), Vol. 5, No. 1, 34-44 (May, 1961).

A method is described for the experimental determination of anisotropy of magnetic susceptibility of rock specimens using a transformer a.c. bridge. The principal susceptibilities are calculated using a least squares solution of the susceptibility tensor on an electronic computer. In the experimental design, sufficient data are obtained to enable an estimate to be made of the precision of the results. An example is given to illustrate the procedure.

21107 THEORY OF THE MAGNETIC PROPERTIES OF IGNEOUS ROCKS IN ALTERNATING FIELDS.

F.D.Stacey.

Phil. Mag. (GB), Vol. 6, 1241-60 (Oct., 1961).

Each magnetic grain in a rock contains ferromagnetic domains with a range of sizes, the small ones being magnetically harder and responding less readily to demagnetizing fields than the larger ones.

By exposing a grain which had a thermoremanent magnetic moment to an alternating field, domains larger than a critical size are demagnetized, leaving the smaller domains unaffected. Domain size distributions are calculated for spherical and cubical grains and used to derive characteristic curves of the fraction of an initial thermoremanent magnetization which remains after demagnetization in a progressively increasing field. Coercive force, saturation remenance and anhysteretic magnetization are also calculated from the domain size distributions. Irregularities of grain shape are shown to lead to a pseudo-single-domain behaviour which is responsible both for very hard components of thermoremanent moments and for the fact that small, randomly directed moments may be found to remain after rocks have been demagnetized in the highest fields.

THE MAGNETIC PROPERTIES OF ILMENITE—HAEMATITE CRYSTALS. See Abstr. 20070

21108 STRESS EFFECTS ON THERMOREMANENT MAGNETIZATION. P.M.Scott and F.D.Stacey.
Nature (GB), Vol. 191, 585-6 (Aug. 5, 1961).

It is pointed out that there is no discrepancy between the results of Hall and Neale on thermoremanent magnetization of igneous rocks cooled under stress in a small magnetic field, and those of the authors. This is due to the different degree of anisotropy of the rocks: small (2%) in the case of authors' experiments, large (at least 13%) in those of Hall and Neale. A limit of 10% was suggested previously as acceptable for rocks used in palaeomagnetic studies, but it may be necessary to impose a more stringent limit than hitherto. B.Cimbleris

21109 STRESS EFFECTS ON THERMOREMANENT MAGNETIZATION. J.M.Hall.
Nature (GB), Vol. 191, 586 (Aug. 5, 1961).

Reply to preceding paper. The susceptibility anisotropy due to pressure appears of negligible importance in the production of remanent pressure effects, since the maximum obtained for fine grained specimens is only ±1.5% about the mean field direction, while a maximum scatter for coarse specimens was ±4%. Anisotr ies of 1% or less between axial values of initial susceptibility were found for all rocks investigated, with the exception of those containing pyrrhotite. B.Cimbleri

21110 PALAEOMAGNETISM AND THE ANCIENT RADII OF THE EARTH. L.Egyed.
Nature (GB), Vol. 190, 1097-8 (June 17, 1961).

A very simple generalization is given which permits the utilization of sampling localities not on the same meridian in determining the ancient radii of the earth from palaeromagnetic measurements. D.S.Paras

21111 COMPARISON OF ANCIENT CLIMATES WITH THE ANCIENT LATITUDES DEDUCED FROM ROCK MAGNETIC MEASUREMENTS. P.M.S.Blackett.
Proc. Roy. Soc. A (GB), Vol. 263, 1-30 (Aug. 22, 1961).

A systematic comparison has been made of the ancient magnet latitudes of Europe, North America, India, Australia and South Africa with the evidence of ancient climates as deduced from geological data, in particular from the distribution of salt, glaciations and fossil corals. In spite of some discrepancies, the general agreement is close enough to lend support to the assumption that th ancient magnetic latitudes, calculated on the hypothesis of an axial dipole field, do represent also the ancient geographical latitudes. This support for the reliability of the magnetic data as a whole gives support for the hypothesis of continental drift and is opposed to the hypothesis that the earth's ancient field differed greatly from that of a dipole.

BIOPHYSICS . PHYSIOLOGICAL PHYSICS

21112 SPECTRAL TRANSMISSION AND SCATTERING PROPERTIES OF RED BLOOD CELLS.
R.A.MacRae, J.A.McClure and P.Latimer.
J. Opt. Soc. Amer., Vol. 51, No. 12, 1366-72 (Dec., 1961).

Spectral curves of direct transmittance, diffuse transmittance, and scattering by partial layers of oriented red blood cells were measured. Also determined were the average optical parameters of a single cell and the cell concentration in the partial layers. The experiments are an extension and refinement of those of Lothian and Lewis [Nature (GB), Vol. 178, 1342 (1956)] on red blood cells and of Latimer (1959) on the green alga Chlorella. By assuming large-particle optics equations were derived to predict the spectral curves in terms of cell and layer parameters. Experimental and theoretical curves are in reasonable agreement.

21113 A.C. TYPE EAR OXIMETER.
T.Asada, K.Sugihara, T.Nakatsuka and Y.Takeda.
J. sci. Instrum. (GB), Vol. 38, No. 5, 224-5 (May, 1961).

The oximeter described by Paul (Abstr. 5264 of 1953), based on the linear relationship between the amplified voltage output and the logarithm of the linear light intensity, is shown to be insufficiently sensitive for reliable analysis of oxygen in general, and in human blood in particular. G.I.W.Llewelyn

21114 REPORT OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL UNITS AND MEASUREMENTS (ICRU) 1959.
Handb. Nat. Bur. Stand. (USA), No. 78, 90 pp. (1961).

This handbook is a revision of the NBS Handbook 62. It deals with the latest discussions of the ICRU on units and measurements in radiation dosimetry and also with the specification of radiation dose. It accepts that the quantities "absorbed dose" and "exposure dose" are both needed and gives in some detail the underlying philsophy behind these units. The large section on clinical and biological applications includes a discussion of absorbed dose in bone marrow, the specification of radiation dose in clinical practice and a report of an enquiry on current errors in clinical dosimetry. There is further a substantial section on the physical aspects of dosimetry including discussions on measurement standards, of methods of calculating the absorbed dose from measured ionizatio and a summary of newer methods of dosimetry including chemical dosimetry, calorimetric dosimetry, solid state dosimetry and photographic dosimetry. Appendixes deal with committee reports on measurements of radioactivity for radiological use, on phenomena associated with focal spots in X-ray tubes and in the estimation of integral absorbed doses. H.Mille

INTERFOCAL VISCOSITIES OF PROTEIN MONOLAYERS. See Abstr. 15782

LIQUID SCINTILLATION COUNTING OF C^{14} PLASMA PROTEINS. See Abstr. 17004

X-RAY SCATTERING BY A WATER-SLAB RADIOLOGICAL PHANTOM. See Abstr. 19171

RADIOACTIVITY IN CERVIDAE ANTLERS. See Abstr. 1937

Hearing . Speech

21115 AN INVESTIGATION INTO A UNIFIED PRESENTATIO OF THE LOUDNESS BUILD-UP LAW FOR ARBITRAR COMPLEX NOISE EXCITATION. H.Niese.
Hochfrequenztech. u. ElektAkust. (Germany), Vol. 70, No. 1, 5-17 (Feb., 1961). In German.

Gives a fairly full account of theoretical and experimental aspects of loudness build-up perception. A suddenly applied sound does not give an instantaneous subjective impression. The effect i thought to be approximately exponential. If a burst of sound is gradually reduced in time presentation, the loss of subjective effec can be estimated and an expression for the subjective time delay may be evolved. Experimental procedures and reliable computational routines are described. A team of listeners was used to obta subjective judgements. 14 refs., mainly to the author's previous work. M.L.Gayfor

21116 PHASOR ANALYSIS OF SOME STEREOPHONIC PHENOMENA. B.B.Bauer.

. Acoust. Soc. Amer., Vol. 33, No. 11, 1536-9 (Nov., 1961).

An improved understanding of some stereophonic phenomena may be obtained by use of acoustical pressure phasors to portray sound pressure at the ears of the observer. With the help of phasors it is possible to expand and modify certain conclusions of previous observers, and to validate some previously unpublished observations; a stereophonic "law of sines" is derived. The existence and location of "out-of-bounds" stereophonic image is nalysed and verified. The "allowed maximum out-of-phase ratio" s derived, together with the observation that this maximum is exceeded by certain microphone arrays. The motion and elevation of the centre image in stereophonic reproduction is observed and explained.

21117 AUDIBILITY OF PERIODIC PULSES AND A MODEL FOR THE THRESHOLD. J.L.Flanagan.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1540-9 (Nov., 1961).

Thresholds of audibility are determined by the Békésy echnique for four periodic trains of rectangular pulses. The pulses of a given train are uniform in amplitude and duration, and the trains differ in their periodic patterns of pulse polarity. The parameters considered are pulse rate, pulse duration, and polarity pattern. The stimuli are presented binaurally in quiet over headphones. Data for four subjects are reported. The results show the threshold amplitudes to be little dependent upon polarity pattern. For pulse rates less than about 100 p.p.s. the thresholds are also little dependent upon pulse rate. They approach constant values determined by pulse duration. Above 100 p.p.s. the thresholds diminish with increasing pulse rate. The experimental technique also provides an estimate of the intensity limen at threshold. An analytical specification of the stimulus is derived which provides an objective correlate of the threshold percept. An electrical circuit model of the threshold is developed which takes account of middle-ear and basilar membrane transmission. The threshold model reflects a constancy of percept over a pulse-rate range of 10 octaves and a pulse-duration range of ten to one. Its application to the metering of subjective loudness is suggested.

21118 PERCEPTION OF PITCH, TIMBRE, AND LOUDNESS. R.A.Jenkins.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1550-7 (Nov., 1961).

If a narrow bandpass filter is driven by a periodic train of narrow rectangular pulses, the resultant wave train elicits a strong pitch perception which varies monotonically with the pulse repetition rate. This periodic wave train can be used as a pitch reference to match against various stimuli. Consideration of double wave train stimuli with various delays establishes a sharp dichotomy between the perception of pitch and timbre. Further evidence is adduced in support of the development of a partial model of psychoacoustic perception which is plausible in terms of the known physiological mechanisms. In brief, the total acoustic stimulus undergoes a differential filtering action along the cochlear partition due to the resonant characteristic of the cochlear structure. The response characteristic of any particular segment of the partition exhibits a single broad peak and consequently has a relatively fast time response. The envelope of the response is assumed to be detected by a relaxation detector having a relatively wide dynamic range, and periodicity of the envelope is detected by a delay-line detector. The second-order time envelope of the cochlear-partition response defines a function over the length of the partition. The shape of the envelope (along the partition) of the absolute value of this function elicits the perception of the timbre structure of the total stimulus. The total area under this envelope elicits the perception of the loudness of the total stimulus. This combination of broad-band spectral filtering, envelope detection, and delay-line periodicity detection provides both a mechanism for relatively sensitive pitch discrimination and for spectral discrimination with relatively fast time response.

21119 CONTRALATERAL THRESHOLD SHIFT AND REDUCTION IN TEMPORARY THRESHOLD SHIFT AS INDICES OF ACOUSTIC REFLEX ACTION. M.Loeb and J.L.Fletcher.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1558-60 (Nov., 1961).

The purpose of the experiment to compare the effectiveness of narrow band noise and a train of clicks in eliciting the middle-ear acoustic reflex, and to correlate two methods of estimating amount of reflex activation. One method involved measurement of increase in threshold in the contralateral ear, the other, measurement of reduction of temporary threshold shift (TTS) produced by a series of gun shots. Sixteen subjects were employed. Shifts produced by the clicks and noise were of the same order of magnitude (after correction for the direct masking effect by the clicks), but there was considerable reflex adaption to the noise and none for the clicks. Correlations between contralateral threshold shift and reductions of TTS were small and not significant.

21120 HEARING THRESHOLD FOR PERIODIC TONE PULSES. R.Plomp.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1561-9 (Nov., 1961).

In continuation of a previous paper (Abstr. 10472 of 1959), the relation between threshold, repetition time, and duration for periodically repeated tone pulses is treated. Experimental data at test frequencies of 250, 1000, and 4000 c/s appeared to agree very well with a derived relation based on the following assumptions: (a) switching on a sinusoidal signal of intensity I results in an effect. s, somewhere in the hearing pathway, which approaches its final value asymptotically according to an exponential function; (b) switching off this signal gives a decay of s also according to an exponential function; (c) perception occurs when s exceeds a critical value s_0. For the time constants of the growth and decay of s the same value could be chosen, being in agreement with the corresponding value for single tone pulses (0.2-0.3 sec). For very short repetition times, the data deviate from the predicted curves, which is explained by the assumption that energy integration is restricted to a fixed bandwidth. These critical bandwidths determined for the periodic tone pulses are also in harmony with the results for single pulses.

21121 MASKING OF PULSED TONES BY BANDS OF NOISE. A.M.Small, Jr and R.A.Campbell.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1570-6 (Nov., 1961).

If a 2200 c/s tone is pulsed 150 times/sec under appropriate conditions, a low pitch (periodicity pitch) will be heard corresponding to that of a 150 c/s pure tone. This experiment investigates the effectiveness of different bands of filtered noise in the masking of such pulses and in the masking of two pure tone stimuli, 150 and 2200 c/s. Although the pulses and 2200 c/s pure tone yield quite different pitches, the present results indicate that the masking of each requires nearly identical frequency components and levels of noise. The 150 c/s tone, although yielding a pitch approximately that of the pulses, requires greatly different characteristics of noise to mask it. Considering differences in apparatus and technique, reasonable agreement with other studies of pure tone masking by bands of noise is found. If masking is viewed as a neural phenomenon, these data provide additional evidence of the neural nature of periodicity pitch.

21122 STIMULUS VERSUS RESPONSE UNCERTAINTY IN RECOGNITION. J.A.Swets and S.T.Sewall. C

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1586-92 (Nov., 1961).

In the framework of a very simple recognition task, the question is raised of the relative efficacy of specifying the stimulus alternatives before and after the stimulus is presented. Experiments show that information given before the observation to facilitate recognition and information given after the observation have little, if any, effect. It is concluded that the facilitative effect of restricting alternatives, in the task studied, depends on a perceptual mechanism rather than on a response mechanism. These experiments are discussed in connection with two current psychological theories; the theory of signal detectability, which is essentially a perceptual theory, and the theory of individual choice behaviour, which is essentially a response theory. The results of another experiment, the only other experiment discovered to date for which these two theories make different predictions, are also reported. In this experiment, too, the results are in agreement with the detection theory.

21123 TEMPORARY THRESHOLD SHIFTS FROM TONES AND NOISE BANDS OF EQUIVALENT RMS SOUND-PRESSURE LEVEL. P.O.Thompson and R.S.Gales.

J. Acoust. Soc. Amer., Vol. 33, No. 11, 1593-7 (Nov., 1961).

In order to compare the temporary threshold shift (TTS) produced by bands of thermal noise with that produced by pure tones, eight ears (four subjects) were exposed to pure tones of 500 and 3200 c/s, and to noise bands 5 c/s, one-third octave, and one octave wide, centred at these same frequencies. The exposures were at a sound-pressure level of 110 dB. After exposure, the subject tracked his 4000 c/s threshold for 3 min and then his 500, 1000, 2000, 4000, and 6000 c/s thresholds for the next 12 min on a Békésy type audiometer. The threshold shifts at these frequencies were found to be essentially the same regardless of the exposure stimulus type. The threshold shifts from exposures in the 500 c/s region were very small, but the "bounce" phenomenon was particularly prominent.

21124 LOCALIZATION EFFECTS WITH STEADY THERMAL NOISE IN ONE EAR AND PULSED THERMAL NOISE IN THE OTHER. W.R.Thurlow and L.F.Elfner.
Science (USA), Vol. 134, 617-18 (Sept. 1, 1961).

When the duration or repetition rate of pulses in the left ear is increased while steady, in-phase, thermal noise sounds in the right ear, the pulses are heard to move toward the median plane. At still longer durations (for a given repetition rate) the loudness of noise on the right diminishes, until finally all sound is localized at the median plane.

21125 PHASIC AND TONIC RESPONSES OF THE TYMPANAL ORGANS OF THE TETTIGONIA VIRIDISSIMA GRASSHOPPER. H.Autrum.
Acustica (Internat.), Vol. 10, No. 5-6, 339-48 (1960). In German.

The reactions of the tympanal organs of the grasshopper, Tettigonia viridissima, were investigated by recording action potentials from the tympanic nerves. The reactions are independent of the frequency of sound in the range from 1 to 100 kc/s. The organs are not capable of analyzing frequencies. The tympanal organs give phasic responses to transient components of sound of sufficient steepness (the upper and lower limits of steepness depending on incompletely understood circumstances, it could be transitory or modulations). They respond tonically to constant tones. Phasic and tonic responses are distinguished by their latencies and their activation times. Latency of the phasic response is about 1 ms; latency of the tonic response about 3.5 to 4 ms. The phasic response already appears after a single cycle of a tone of 20 or 40 kc/s; the activation time of the tonic response is at least 1.25 ms (hence, at 20 kc/s, at least 25-30 cycles). The absolute refractory period of the phasic response is 2 ms; the relative, about 12 ms. The tonic response appears in the refractory period of the phasic response. There are interactions between the two responses. A constant tone reduces the phasic response (masking effect), but does not cause it to disappear entirely. The maximal modulation frequency of a tone is ca. 350 to 400 c/s. Clicks also arouse single responses up to a frequency of about $400\ s^{-1}$.

SCIENCE AND MUSIC. See Abstr. 18526

PHONETIC TYPEWRITER. See Abstr. 18527

PROCEDURE FOR CALCULATING LOUDNESS: See Abstr. 18535

Vision

DYNAMIC CHARACTERISTICS OF VISUAL PROCESSES. See Abstr. 18551

21126 NOTE ON THE EFFICIENCY OF TRIANGULAR LIGHT PULSES. M.Bittini.
Atti Fond. Ronchi (Italy), Vol. 16, No. 1, 47-8 (Jan.-Feb., 1961).

Triangular and square impulses are said to follow different perception/intensity functions. R.A.Weale

21127 ON THE EXISTENCE OF PANUM'S ZONES. M.Aguilar, E.Sauras and M.Gómez.
An. Real. Soc.Espan. Fis. Quim. (Spain), Vol. 56, No. 3-4, 91-2 (March-April, 1960). In Spanish.

The hypothesis of Le Grand regarding the reality of Panum's fusional areas is not found to account for experiments in which binocular fusion is measured as a function of luminance and retinal eccentricity. R.A.Weale

21128 VISUAL ACUITY IN MESOPIC VISION. M.Aguilar, E.Sauras and M.Gómez.
An. Real Soc. Espan. Fis. Quim. (Spain), Vol. 56, No. 11-12, 281-4 (Nov.-Dec., 1960). In Spanish.

Visual acuity was measured monocularly and binocularly at various luminance levels in a range of retinal eccentricities between 0 and 25°. The results follow an expected course. R.A.Weale

21129 LINEAR MODELS FOR CONTRAST PHENOMENA. J.C.Bliss and W.B.Macurdy.
J. Opt. Soc. Amer., Vol. 51, No. 12, 1373-9 (Dec., 1961).

Discrete and continuous linear models are defined to describe contrast phenomena such as Mach bands. Two-sided z transforms are used to describe the discrete systems and Fourier transforms are used to describe continuous systems. A psychological model is defined based on the work of von Békésy (see Abstr. 18566 of 1960) on s and vision which suggests a "neural unit" consisting of an area of sensation surrounded by an area of inhibition. A physiological mode is also defined based on the experiments of Hartline et al. [Annals of the New York Academy of Sciences, Vol. 74, 210 (1958)] describin lateral neutral interaction in the eye of Limulus. It is shown that the physiological model is related to the psychological model and that the form of the physiological inhibitory coefficients k_p uniquely specify the form of the psychological neural unit h_p, and vice versa. Also, by assuming a "blurring" of the stimulus spatial distribution as the excitation distribution of the receptors a neural unit is obtained from the physiological model which is similar to the psycholo gical neural unit suggested by the experiments of von Békésy. Illustrative examples are given.

21130 PHOTIC DRIVING OF THE CRITICAL FLICKER FREQUENCY. M.Alpern and S.Sugiyama.
J. Opt. Soc. Amer., Vol. 51, No. 12, 1379-85 (Dec., 1961).

A light pulsing above the critical flicker frequency (CFF) significantly elevates, and one pulsing below CFF significantly depresses, subsequent CFF measurements. The characteristics of these phenomena, their dependence upon the duration of fixation, the luminance of the measuring and the adaptation lights, and the duration of the after-effect are described in the present series of experiments. The effects are virtually as pronounced if the pulsing adaptation light is viewed with one eye and the measuring light with the other, as when both adapting and measuring lights are seen by the same eye. It is proposed that the driving is a direct consequenc of a change in the frequency characteristics of the responses of cell in the visual system to photic stimulation. Measurements of the brightness of lights, pulsing at various rates immediately after viewing lights pulsing above and below the CFF, confirm certain predictions of this hypothesis.

21131 LIMITS OF HUMAN VISION. R.A.Weale.
Nature (GB), Vol. 191, 471-3 (July 29, 1961).

The author's fundus reflectometer [Optica Acta (GB), Vol. 6, No. 2, 158-75 (Oct., 1959)] was used in a study relating the photosensitivity of retinal extra-foveal pigment in the living human eye with the absolute visual threshold. It is suggested that the constitution of the pigment is such that the lower limit of the human visual intensity gamut is such as to be governed by quantum physics, while the upper limit coincides with the safety-level of ocular tissues exposed to thermal hazards. R.A.Weale

21132 A SIMPLE AFTER-IMAGE METHOD DEMONSTRATING THE INVOLUNTARY MULTIDIRECTIONAL EYE MOVEMENTS DURING FIXATION. F.J.Verheijen.
Optica Acta (Internat.), Vol. 8, No. 4, 309-11 (Oct., 1961).

An after-image method is described with which the following features of the eye movements during fixation can be demonstrated in an easy way to a large audience: (a) the drifts; (b) the flicks anc the inhibition of vision during the flicks; (c) the multidirectional character of both drifts and flicks; (d) the coordination of the move ments in both eyes; and (e) the order of magnitude of the movemen

21133 THE SENSITIVITY PERFORMANCE OF THE EYE, IN THE PRESENCE OF VARIOUS LIMITING MECHANISMS OF DIFFERENT ORIGIN. M. v. Ments.
Optica Acta (Internat.), Vol. 8, No. 4, 313-22 (Oct., 1961).

The eye is able to distinguish two neighbouring domains of comparable luminance, only if the signal to noise ratio, under well specified conditions, exceeds a certain minimum value. The noise can be due to different sources. The class of cases, wherein the statistical fluctuations in the number of messages sent from the retina inwards set a natural limit to perceptibility, has received ample attention. In looking at a scene with the aid of an intermedia device (e.g. an image intensifier), at least two other phenomena ma still restrict the perceptibility. The first phenomenon is a kind of amplifier noise, manifesting itself as a noise background on the ulti mate viewing screen. The second phenomenon is the occurrence of a low number of events in one of the intermediate stages of the npound vision process in question. These two kinds of noise are cidated and the sensitivity performance of the eye in their presence calculated.

21134 VISUAL ACUITY AND IMAGE CLARITY IN EXTRA-FOVEAL VISION. M.Joyal and Y.Le Grand.

ev. Opt. (France), Vol. 39, No. 1, 19-23 (Jan., 1960). In French.

The Landolt C was used in acuity tests at a perimetric angle 15°. Visual acuity is not optimal in this region with the sharpest ssible retinal image, but rather when the latter is somewhat urred. R.A.Weale

21135 RELATIVE SIZES OF RETINAL IMAGES AND BINOCULAR SPACE VISION. C.Bourdy.

ev. Opt. (France), Vol. 39, No. 2, 64-76 (Feb., 1960). In French.

The relative sizes of the retinal images were varied by amounts anging from 0-12% and a study was made of the resultant apparent pace distortion. R.A.Weale

21136 CONTRIBUTION TO THE STUDY OF MICROFLUCTUATIONS OF THE ACCOMMODATION OF THE EYE.

.Arnulf and O.Dupuy.

ev. Opt. (France), Vol. 39, No. 5, 195-208 (May, 1960). In French.

A Foucault circle (with alternate black and white segments) as projected onto the human fundus. The aerial image of this ndus image was projected by the eye on an emulsion so that its tate of adaptation could be recorded. Microfluctuations were hown to be minimal when accommodation was small or relaxed. R.A.Weale

21137 NONLINEAR PROPERTY OF THE VISUAL SYSTEM AT FUSION. D.M.Forsyth and C.R.Brown.

Science (USA), Vol. 134, 612-14 (Sept. 1, 1961).

The response of the visual system to intermittent stimulation at rates above the fusion point is generally considered to be independent of frequency, that is, linear with respect to time-average uminance. However, trains of 1000 light pulses per second alternated successively with trains of 500 light pulses per second may be perceived as flickering even though the time-average luminance s the same in each train.

21138 A BINOCULAR CONTRAST EFFECT. A.Fiorentini and T.Radici.

Vision Res. (GB), Vol. 1, No. 3-4, 244-52 (Oct., 1961). In French.

The effect involves interaction between non-corresponding areas of the two retinae: when one eye is presented with a peripheral field and then a non-corresponding peripheral area of the retina of the other eye is strongly illuminated, the observer reports a darkening of the first field. The effect cannot be ascribed to pupil contraction as it occurs with artificial pupils 2 mm in diameter. This binocular inhibition seems to be independent of the retinal location of the inhibiting stimulus (at least for small retinal eccentricities) and to depend on the relative intensity of illumination at the two eyes.

21139 INFLUENCE OF NOISE ON CERTAIN VISUAL FUNCTIONS. P.Grognot and G.Perdriel.

Vision Res. (GB), Vol. 1, No. 3-4, 269-73 (Oct., 1961). In French.

A complex noise above 90 dB, heard during 5 to 10 min, did not cause any decrease in visual acuity, visual field, or the physical component of stereoscopic sense. However, it was observed that the practical sense perception was disturbed. Colour perception was also modified with a trend to protanomaly as measured with the Nagel anomaloscope. The nocturnal morphoscopic sense, as measured with a scotoptometer of Beyne, is strongly impaired. This decrease of night vision capacity under the influence of noise seems to be due to a central action.

21140 CONTRIBUTION TO THE STUDY OF THE CORRELATION BETWEEN THE ANOMALY QUOTIENT AND THE EXTENT OF COLORIMETRIC CONFUSIONS IN CONGENITAL ANOMALOUS TRICHROMATS. G.Verriest.

Rev. Opt. (France), Vol. 39, No. 10, 467-71 (Oct., 1960). In French.

Measurements made with a Nagel anomaloscope and the Farnsworth Panel D15 revealed no significant correlation between the two tests. R.A.Weale

21141 THE LAND DEMONSTRATIONS IN RELATION TO COLOUR THEORY AND COLOUR PHOTOGRAPHY.

C.E.M.Hansel.

J. photogr. Sci. (GB), Vol. 9, No. 5, 290-8 (Sept.-Oct., 1961).

Colour effects observed in Land photographs suggest other well-known perceptual phenomena. An explanation of the Land colours must, however, be in terms of the basic mechanisms on which all these phenomena are dependent. Trichromatic theory postulates the nature of the initial stage in the colour reception process, but it has little applicability to the qualitative phenomena of colour vision. The opponents theory of Hering is here used as a basis for later stages in the visual process in order to explain qualitative phenomena in terms of neural mechanisms. Methods are described by means of which tristimulus specifications for the receptors can be selected which are appropriate to the trichromatic theory and to an opponents theory based on the trichromatic theory. The Land photographs can then be understood in terms of such a system, provided there occur changes in sensitivity of the receptors, or adaptive changes which simulate such changes in sensitivity at a later stage in the visual process. Such changes are partly dependent on interaction between outputs corresponding to a particular retinal area and those corresponding to a larger retinal area. These mechanisms are also discussed in relation to the suppressor mechanism for chromatic aberration. Colour photography is essentially satisfied by a trichromatic process as a photograph has ideally, to produce similar activity at the first stage in the visual process as do the objects photographed. But in so far as modifications are necessary in a photograph to compensate for the limitations of photographic reproduction and the conditions in which the photograph is viewed, it may be useful to go beyond the trichromatic scheme both to understand the nature of such modifications and to simplify their implementation. The Land demsonstrations are important as they highlight basic perceptual phenomena and provide a means of obtaining quantitative data which may reveal the nature of the underlying mechanisms.

21142 COLOR INDUCTION AND HUE DISCRIMINATION. L.W.Bivens.

Science (USA), Vol. 134, 732 (Sept. 15, 1961).

A very close relationship has been found between hue discrimination thresholds and the differences in wavelength necessary to produce "full colour" from two monochromatic light sources. This finding suggests a need for certain research in the area of colour induction.

21143 ON ACQUIRED DEFICIENCY OF COLOUR VISION, WITH SPECIAL REFERENCE TO ITS DETECTION AND CLASSIFICATION BY MEANS OF THE TESTS OF FARNSWORTH.

J.François and G.Verriest.

Vision Res. (GB), Vol. 1, No. 3-4, 201-19 (Oct., 1961).

The various forms of acquired colour vision deficiencies were well studied by Koenig, von Kries, Koellner, and others some 70 years ago, using spectral devices. However, these studies have been greatly neglected, and it is only within the last few years that there has been a renewed interest in this field, of which the first approach has been greatly facilitated by the Panel D-15 and the 100-Hue of Farnsworth. In general, nearly all ocular diseases give rise to absorption systems, while lesions in the deeper layers of the retina elicit a predominant reduction of the blue—yellow sense, and lesions in the ganglion layer and in the optic nerve mainly result in a reduction of the red—green sense. 78 refs.

21144 THE COLOUR CHANGE OF MONOCHROMATIC LIGHT WITH RETINAL ANGLE OF INCIDENCE.

J.M.Enoch and W.S.Stiles.

Optica Acta (Internat.), Vol. 8, No. 4, 329-58 (Oct., 1961).

The few previous measurements of the small change of apparent colour of a monochromatic light stimulus when its angle of incidence on the foveal retina is varied (or SC II effect), have been confined to changes of apparent hue. A differential, three-colour mixture method, with alternating instead of juxtaposed presentation of the test and comparison stimuli, has now been applied to determine the complete colour change, hue and saturation. For the main subject, the results show hue shifts of the expected kind and a small but significant supersaturation of the apparent colour of an obliquely, compared with a normally incident stimulus, in the wavelength range 485 to 510 mμ. From earlier qualitative observations, such a supersaturation appears to occur for most subjects. The SC II colour changes are attributable to differences in the directional response of the receptors associated respectively with the three colour systems of the trichromatic scheme. From the relative spectral sensitivities of these systems and the complete SC II colour changes, the variation with wavelength of the directional sensitivity of each system has been computed for the data of the main subject. The possibility of explaining the derived wavelength variation in terms of self-screening by visual pigment present in the receptors in sufficiently high density, is examined. Self-screening appears not to be a factor for the blue-sensitive system, and although for the red- and green-sensitive systems it predicts minima in the directional sensitivity versus wavelength curve, resembling those observed, the quantitative agreement is poor and there are other objections. The wave-mode disposition of light in the receptors, now being studied, should yield a better explanation.

21145 THE PERCEPTION OF LIGHT AND COLOUR AND THE PHYSIOLOGY OF VISION. I. THE MECHANISM OF PERCEPTION. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 52, No. 6, 255-66 (Dec., 1960).

21146 THE PERCEPTION OF LIGHT AND COLOUR AND THE PHYSIOLOGY OF VISION. II. THE VISUAL PIGMENTS. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 52, No. 6, 267-80 (Dec., 1960).

21147 THE PERCEPTION OF LIGHT AND COLOUR AND THE PHYSIOLOGY OF VISION. III. THE CAROTENOID PIGMENT. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 52, No. 6, 281-91 (Dec., 1960).

21148 THE PERCEPTION OF LIGHT AND COLOUR AND THE PHYSIOLOGY OF VISION. IV. FERROHEME AND FERRIHEME. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 52, No. 6, 292-304 (Dec., 1960).

21149 THE PERCEPTION OF LIGHT AND COLOUR AND THE PHYSIOLOGY OF VISION. V. THE COLOUR TRIANGLE. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 52, No. 6, 305-13 (Dec., 1960).

21150 THE PERCEPTION OF LIGHT AND COLOUR AND THE PHYSIOLOGY OF VISION. VI. DEFECTIVE COLOUR VISION. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 52, No. 6, 314-23 (Dec., 1960).

21151 THE PERCEPTION OF LIGHT AND COLOUR AND THE PHYSIOLOGY OF VISION. VII. GENERAL SUMMARY. C.V.Raman.
Proc. Indian Acad. Sci. A, Vol. 52, No. 6, 324-8 (Dec., 1960).

21152 MEASUREMENTS OF THE CONTRAST TRANSMISSION FUNCTIONS OF ANIMAL EYES. R.Röhler.
Optik (Germany), Vol. 17, No. 9-10, 561-7 (Sept.-Oct., 1960).
In German.

Images of point and slit sources formed on the retina of the enucleated eyes of animals were photographed, and the contrast transmission function of the eyes calculated by Fourier analysis of the resulting pictures. The dependence of the transmission function on image position was investigated.

TECHNIQUE . MATERIALS

21153 DYNAMIC COMPRESSION MEASUREMENTS OF CUSHIONING MATERIALS UTILIZING AN ANALOGUE COMPUTER. B.H.Venning and J.Guttridge.
Brit. J. appl. Phys., Vol. 12, No. 11, 621-4 (Nov., 1961).

Theoretical analysis of the design of packaged systems is readily carried out on an electronic analogue computer, but to introduce a realistic stiffness term it is necessary to know the dynamic performance under conditions similar to that of actual impact. A system was devised using an electrodynamic force generator with force and displacement transducers to incorporate a sample of cushioning material into the analogue system, thus solving the cushioning problem under dynamic conditions. At the same time, waveforms of force—time and force—displacement are produced, showing the nature of the nonlinear stiffness and the extent of energy dissipation.

21154 DIRECT-READING BALANCES FOR PERCENTAGE MOISTURE CONTENT.
J.G.Downes, B.H.Mackay, L.G.Bellamy and V.D.Burgmann.
J. sci. Instrum. (GB), Vol. 38, No. 12, 484-8 (Dec., 1961).

This paper describes two types of balance which indicate per cent moisture content directly, and in which the initial sample weight may vary within wide limits. They were designed primarily for measuring the moisture in wool at various stages in processing and for this purpose are used in conjunction with a hot-air drying apparatus. The same balances can be used to determine the percentage content of removable components in many other materials. An analysis of the principles of operation of the balances is given and experimental models are described.

21155 PROGRESS IN NON-DESTRUCTIVE TESTING. VOLUME 2. Edited by E.G.Stanford and J.H.Fearon.
London: Heywood (1960) 250 + vii pp.

For abstracts of some of the papers in the above volume see Abstr. 12649, 13144, 13190, 13676, 14882 and 14920-1 of 1961.

21156 MAGNETIC CRACK DETECTOR.
P.H.Dawson.
J. sci. Instrum. (GB), Vol. 38, No. 9, 365-6 (Sept., 1961).

When using a gear simulation disk machine to perform experiments on pitting it is often desirable that pits or the cracks that precede pits should be detected at the earliest moment after their formation, if possible while the disk is rotating. A method for doing this, using a magnetic detector in the form of a tape recorder head, is described. The technique is also applicable to the detection of cracks in other components such as Wohler fatigue specimens.

21157 DIAMOND KNIFE TROUGH FOR THE ULTRA MICROTOME. R.Phillips and J.H.Lucas.
J. sci. Instrum. (GB), Vol. 38, No. 12, 506-7 (Dec., 1961).

A diamond knife trough is described which does not rely on grease, wax or plastic seals to prevent cutting-fluid leakage. This allows organic solvents such as xylol to be used as cutting-fluid, without contaminating the knife and producing leaks. This type of cutting-fluid is required for easily oxidizable metals such as magnesium. The new knife trough also permits the mounted knife to be cleaned in organic solvents without damage to the trough, and without impairing the seal.

21158 ELECTROMAGNETIC BEARING.
H.Sixsmith.
Rev. sci. Instrum. (USA), Vol. 32, No. 11, 1196-7 (Nov., 1961).

A shaft is supported by means of a laminated rotor which is magnetically suspended inside a four pole laminated stator. The diameter of the rotor is $1\frac{3}{4}$ in. and the radial clearance is 0.002 in. The position of the shaft is sensed with the aid of four quadrant electrodes which surround the shaft with a small radial clearance. Each electrode provides part of the tuning capacity of an r.f. tuned circuit which is tuned to one side of its resonance peak with respect to an r.f. generator. The r.f. signal is detected and amplified to provide the control current in the corresponding winding on the stator. The bearing was found to run smoothly up to 23 000 r.p.m. With further development, a reliable and useful bearing should result. The use of electromagnetic bearings would appear to be justified in special applications where conventional bearings cannot be employed. They would appear to be useful at cryogenic temperatures, in vacuums, and in applications where contamination with lubricants must be avoided. Since there is no wear the life should be indefinite.

21159 INSTRUMENT FOR MAKING INDIVIDUAL SPHERES TO A HIGH DEGREE OF ACCURACY. P.H.Cross.
Rev. sci. Instrum. (USA), Vol. 32, No. 11, 1179-81 (Nov., 1961).

Describes a mechanical method of producing polished spheres constant in radius to about one micro-inch. Spheres were made to this accuracy in anisotropic materials such as yttrium iron garnet and also in steel, sapphire, quartz, and ceramic. The method has not been fully exploited; it may yield even further improved surfaces and also be found suitable for softer materials. The principle may also have application for finishing concave and convex mirror and lens surfaces of small radius. The instrument is also suited for the rapid production of spheres to a lesser degree of accuracy.

21160 NOTE ON THE POLISHING OF SMALL SPHERES OF FERRIMAGNETIC MATERIALS.

J.G.Grunberg, G.Antier and P.E.Seiden.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 979-80 (Aug., 1961).

A method is described for providing high surface polishes on small spheres in relatively short times. Polishing times of 1-2 hr are sufficient to obtained polishes needing as long as three days with conventional tumbling techniques. (Abstr. 7843 of 1954).

P.E.Seiden

21161 AN ION OPTICAL METHOD FOR REPRODUCING MESHES AND APERTURES.

G.Möllenstedt and R.Speidel.
Z. angew. Phys. (Germany), Vol. 13, No. 5, 231-2 (May, 1961).
In German.

Describes a method of replicating grids or apertures by forming a shadow (contact) image of the object with positive ions on a silver substrate. The ions caused an insulating layer of carbon to occur where they strike. The aluminium substrate is then copper plated; plating does not take place over the carbonized areas. The resulting copper replica of the object is then stripped off the substrate.

A.E.I. Research Laboratory

21162 TWO SIMPLE METHODS FOR SPOT WELDING WIRES. S.V.Radcliffe and J.S.White.

J. sci. Instrum. (GB), Vol. 38, No. 9, 363-4 (Sept., 1961).

Two simple pieces of spot welding equipment are described, together with their application to the welding of wires with a wide range of compositions and sizes.

21163 ANTI-DISTORTION MOUNTINGS FOR INSTRUMENTS AND APPARATUS. R.V.Jones.

J. sci. Instrum. (GB), Vol. 38, No. 10, 408-9 (Oct., 1961).

Some principles for the mounting of instrument platforms are discussed. For many optical and mechanical instruments, the working platform may best be protected from external mechanical distortion by supporting or suspending the platform by members, usually three, whose stiffness is much less than that of the platform. At the same time, these members can be stiff enough to give a fairly rigid location. Some possible arrangements are outlined.

PUMP FOR SHAPED FLOW OF ULTRACLEAN SOLUTIONS.
See Abstr. 12859

LEVEL GAUGE FOR LIQUID HYDROGEN AND HELIUM.
See Abstr. 16184

ULTRASONIC FLAW DETECTION: DIFFRACTION EFFECTS AND SIGNAL AMPLITUDE. See Abstr. 16035

21164 VIBRATION MICRO-DISPENSER.

D.K.Butt and P.W.Nicholson.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 986 (Aug., 1961).

A method is described of manipulating very small quantities of a stable isotope; the method was used to divide 2 mg of Ir^{193}, in fine-powder form, into about 50 µg quantities. The unseparated Ir^{193} was contained in a glass tube the axis of which was inclined at a few degrees to the horizontal. This tube was clamped in a stand and the whole apparatus was made to vibrate gently by applying a 50 c/s magnetic field to the post of clamp stand with a relay magnet, separated from the stand by a piece of copper shim. The vibration caused the powder to move slowly down and eventually out of the tube. It was then collected in a capillary tube. By controlling the amplitude of vibration the movement of single grains can be finely controlled. It is suggested that a remotely controlled model could be useful for dispensing radioactive powders.

C.F.Barnaby

21165 METHOD FOR ESTABLISHING A LIQUID COLUMN OF GRADED DENSITY. J.M.Jones.

J. sci. Instrum. (GB), Vol. 38, No. 9, 367-8 (Sept., 1961).

A simple technique was devised to overcome the uncertainties and empiricism of the diffusion method of setting up a liquid column of graded density. This permits the overall density gradient of the liquid and the density at any point within the column to be calculated before the column is set up, allowing considerable precision in the separation of particles and in their density determination. Greater flexibility in the form of the column is possible, including the introduction of steps in the density gradient of the liquid.

21166 DEVICE FOR THE ACCURATE REPRODUCTION OF LIQUID LEVELS AND SOME APPLICATIONS.

G.F.Hewitt and E.Lyall.
J. sci. Instrum. (GB), Vol. 38, No. 9, 369-70 (Sept., 1961).

It was found that a simple suction device can be used to reproduce liquid levels to a very high degree of accuracy. The application of this discovery to level control, collection of liquids under constant head and to the measurement of the volume of large objects is discussed.

21167 APPLICATION OF ALCOHOL IN WATER SOLUTIONS FOR OBTAINING REQUIRED PRESSURES AT LOW TEMPERATURES. N.B.Brandt and A.K.Tomashchik.

Pribory i Tekh. Eksper. (USSR), 1958, No. 2, 113-14 (March-April).
In Russian.

In a constant volume bomb, which uses the anomalous expansion of a liquid at its freezing point for obtaining high pressures at low temperatures, greater uniformity of pressure can be achieved by using a solution of ethyl alcohol in water instead of water. Curves showing the relative rise in volume of the solution in water at the freezing point, and of the pressure in a beryllium bronze bomb at helium temperatures, as a function of alcohol content, are given. [English translation in: Instrum. exper. Tech. (USA), No. 2, 309-10 (March-April, 1958; publ. April, 1959)]

S.Weintroub

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